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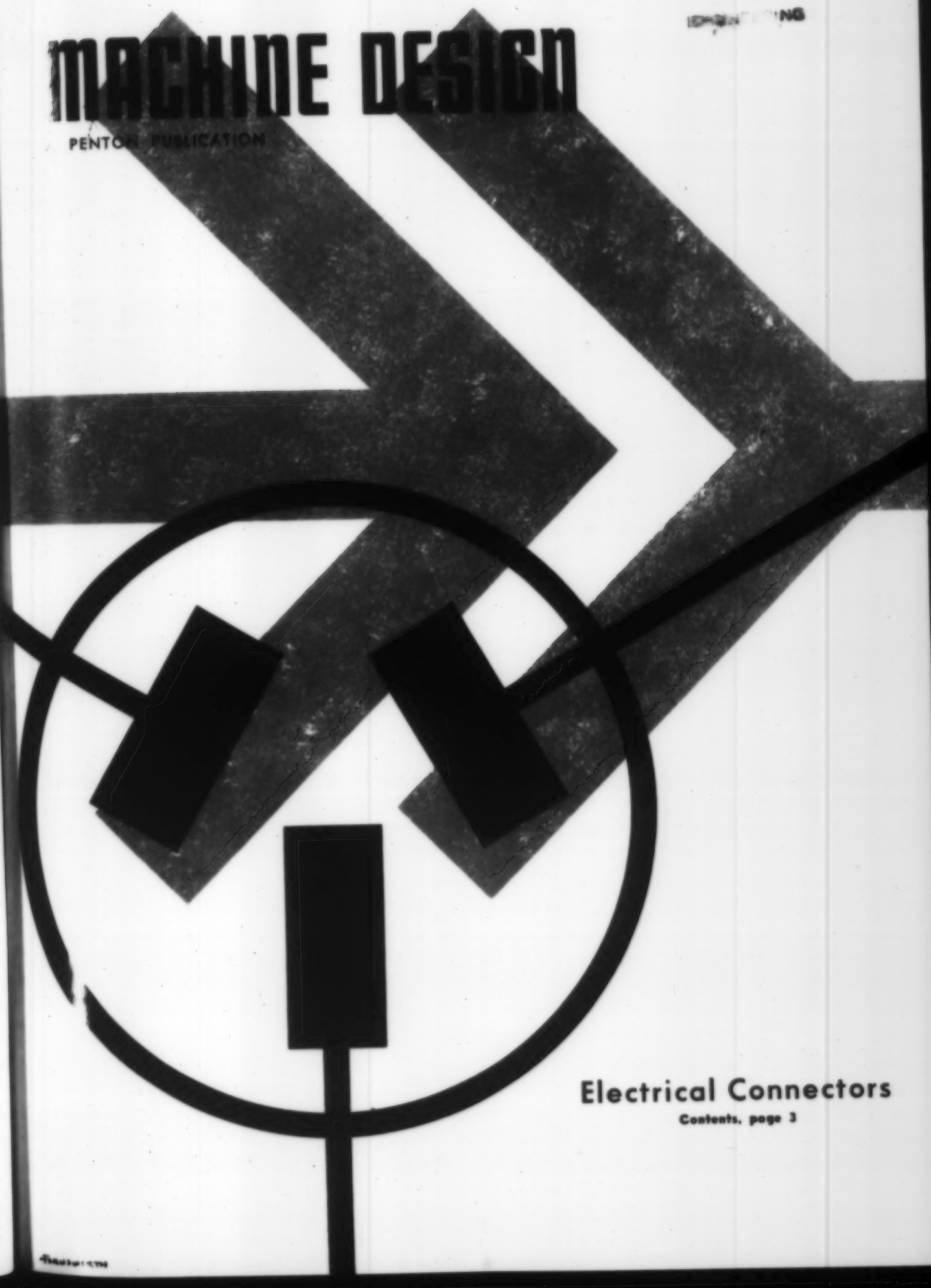
MACHINE DESIGN

PENTON PUBLICATION



Electrical Connectors

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THE NEW CUTLER-HAMMER LINE

OF HEAVY DUTY, OILTIGHT

Pushbuttons, Selector Switches and Lights

The new Cutler-Hammer Pushbutton with double pole contact block that measures only 1⅝" in depth.

The new Cutler-Hammer Indicating Light with separate winding transformer that measures only 1⅝" in depth.

New shallow-depth contact blocks; greater freedom of circuit arrangements; better design; better appearance; better performance. Get them first, get them fast, get them *now*.

Once again the name Cutler-Hammer companions great achievement . . . an amazing and unique new line of heavy duty, oiltight pushbuttons, selector switches and indicating lights. There is nothing to compare with it. The feature that stands out above all is the new basic working unit, the contact block—and its counterpart for the indicating lights, the transformer or resistor. *THIS NEW CONTACT BLOCK MEASURES ONLY 1-3/32" IN DEPTH BEHIND THE MOUNTING PANEL.* A fact of amazing consequence for the vast majority of pushbutton users.

Of even greater consequence is the greater degree of circuit flexibility this new design provides. With its contacts set side by side, "in parallel," electrically isolated from one another . . . *you can apply one voltage on one set, a different voltage on the other. Or you can impress alternating current on one and direct current on the other.* Each pair of contacts has its own actuating plunger; you can throw both simultaneously, or singly or in sequence.

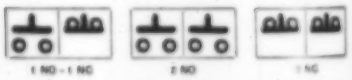
And you can add contact block to contact block, one behind another, easily, simply, swiftly, giving you virtually unlimited circuit possibilities.

There is a complete range of operators: standard or extended length pushbuttons, with regular or mushroom head; selector switches providing maintained contact or momentary contact with spring return in either or both positions; key operators providing in addition momentary contact that becomes maintained on key withdrawal. Pushbuttons available in 5 colors. All operators are chrome-plated for lasting beauty. Indicating lights have new wide-visibility lenses proved by light-meter reading to be most visible of all from any angle. Lights are available with resistor or separate winding transformer. Transformer type with 6-volt bayonet lamp provides multiplied lamp life where shock and vibration prevail.

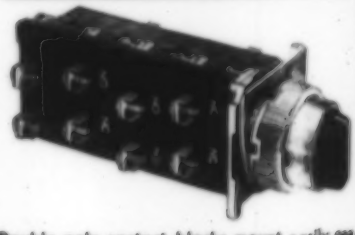
These and many other features are fully described and illustrated in a bulletin just published. Write for it today or see the complete line at your nearest authorized C-H distributor. CUTLER-HAMMER, Inc., 1310 St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.

CUTLER-HAMMER
MOTOR CONTROL
C-H

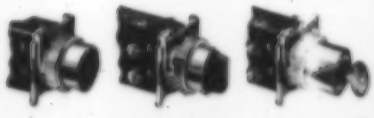
New shallow-depth contact block has electrically isolated contacts, allows different voltage or different current on each pair of contacts.



Three separate contact blocks available; with 1 NO and 1 NC contact; 2 NO contacts; or 2 NC contacts.



Double pole contact blocks mount easily one behind another to provide unlimited circuit combinations.



Every type of operator: pushbutton, selector switch and key operator.

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THE PROFESSIONAL JOURNAL FOR ENGINEERS AND DESIGNERS

MACHINE DESIGN

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Over the Board

Self-Locating Golf Ball

The trend toward miniaturization continues. Latest in the parade is a miniaturized radio built right into a golf ball (see "Engineering News Roundup," Page 14). Lost balls are located with a pocket-sized receiver and directional antenna. One of our editors says that he had somewhat the same idea a few years ago, only instead of using a radio transmitter he thought that a small dollop of radioactive material in the golf ball, along with a portable Geiger counter, might work. Only problem was to keep the Geiger counter from "homing in" on the extra balls in his golf bag. He considered a lead-lined golf bag, thought about the extra load involved, and decided to drop the whole project. Any other bright ideas?

Talking Elevators

Engineers have now endowed self-service elevators with a "voice." In a new system developed by Westinghouse and demonstrated recently in New York, the elevator "brings information and assurance" to passengers not familiar with the elevator system or the building it serves.

As passengers enter, the elevator announces, in cordial, well-modulated tones, "This car up," or "This car down." Later, if the first passenger to enter fails to press a button to select his floor, the invisible voice asks him to "Press your floor button, please." The ghostly vocabulary also includes such conversational bits as "Release the door, please" if passengers attempt to delay the car by holding the door, and "Step to the back of the car, please" if passengers crowd the door. Secret of all this is, of course, magnetic tape recording.

Makes us wonder about the impact on the publishing business. First, there was the gramophone, then talking pictures, talking books (for the blind) and now talking elevators. Maybe, sooner or later, we'll have talking magazines. As you open the cover, a voice announces, "This is MACHINE DESIGN, the Professional Journal for Engineers and Designers" — then through the Contents page and each bit of editorial material. Only problem, though, is time. It would take about 15 hours to "talk" the editorial contents of just one issue. We're sure our readers can cover the same ground with much less effort.

This Month's Cover

Symbols are graphic tools of engineering, but somewhat less frequently are they used as graphic tools by artists. This month, however, cover artist George Farnsworth has come up with a literal translation of engineering symbology into art. For those rusty in electrical "shorthand," the red symbol is a general symbol for electrical connector contacts, male and female, and the black symbol is a three-conductor polarized connector with male contacts used for power-supply applications. The cover highlights assistant editor Larry Shergalis' article on electrical connectors, Page 150.

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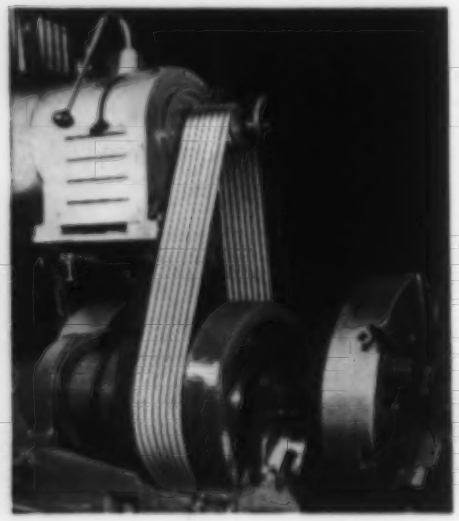
This large lathe was formerly driven by a flat belt which slipped on heavy cuts, stalled and broke tool bits. Savings on broken tool bits alone offset the cost of the drive the first year—and production was increased 25% after the V-belt drive was installed.



concave sides lengthen V-belt life ...cut costs

Hundreds of plants that keep track of V-belt drive costs know this: Gates Vulco Ropes . . . the V-belts with *concave sides*...wear much longer and *cost less per year of service.*

Here is the interesting reason why:

When a Gates V-belt bends around the sheave, the *precisely-engineered* concave sides (Fig. 1) fill out and become straight. Thus the sides of the belt make full, uniform contact with the pulley (Fig 1-A).

Naturally, uniform contact distributes the wear *evenly*. And *even* wear means *longer* wear.

Longer wear saves not only on replacement costs; it also saves the cost of down-time... keeps equipment producing.

Simple test proves value of concave sides

Take a straight-sided V-belt (Fig. 2) and bend it. Feel the sidewalls of the belt bulge out as the belt bends. You see immediately that the bulging sides prevent uniform contact with the pulley (Fig. 2-A). Uneven contact causes faster wear...increases your drive replacement costs.

Let the cost-saving longer life of Gates Vulco Ropes contribute to *your* profits. Specify Gates Vulco Ropes—the V-belts with concave sides (U.S. Patent 1813698). The Gates Rubber Co., Denver, Colorado—*World's Largest Maker of V-belts.*

Gates Engineering Offices and Distributor Stocks are located in all industrial centers of the United States and Canada, and in 70 other countries throughout the world.

7PA-8AA

GATES VULCO ROPE DRIVES

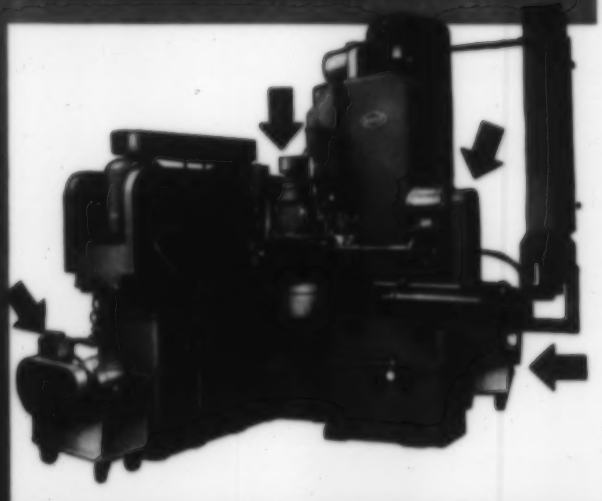
OILGEAR "JK" FLUID POWER FEED PUMPS

AS APPLIED TO BAKER BROTHERS MACHINES

HOW CAN YOU USE THESE SIMPLE, VERSATILE, EASILY APPLIED, PROFITABLE UNITS?

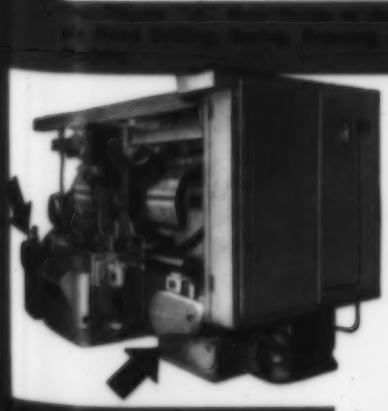
Baker Brothers, Inc., pioneers in machine building, users of Oilgear Feed Pumps since 1925, employ Oilgear "JK" Fluid Power Variable Delivery Feed Pumps on a host of machines including the headline-making 100-foot-long transfer machine and their own commercially available portable hydraulic power unit which you can see in photos Nos. 1 and 3 on this page.

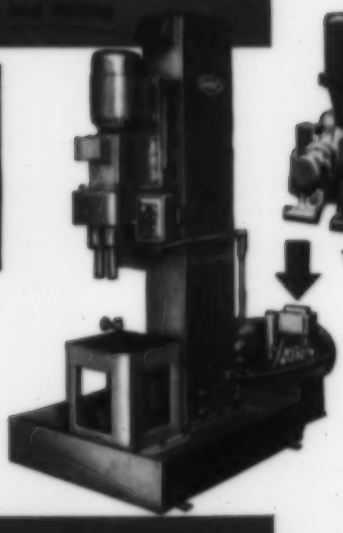
The Oilgear "JK" Feed Pump offers many advantages, not the least of which are easy applicability and accessibility. There's no need in many cases for machine redesign and engineering. And this unit does so much to speed cycle time—traverse speed for example can be 265 times feed rate—that production rises dramatically and costs subside. Both coarse and fine feed rates can be varied infinitely so you at once discover the best rates for your work—and the automatic built-in compensator holds the selected fine feed *unvaryingly*. All functions are controlled automatically, semi-automatically or manually.

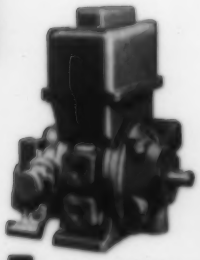


Evidence of Oilgear "JK" dependability is growing. In one large automotive plant, now 75% changed over to Oilgear, hydraulic maintenance staff was cut from 6 men to one man per shift. In another great automotive plant, the records show Oilgear is found to give the finest service of all.

There's much more to tell especially about two new units added to the "JK" line. Why don't you send for free literature that gives all the facts and figures. So you won't forget, send for it now.







Type "JK" Pump Built in four sizes.

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Fluid Power

PIONEERS . . . NOW THREE PLANTS FOR FLUID POWER

PUMPS, MOTORS, TRANSMISSIONS, CYLINDERS AND VALVES

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about

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BALL BEARINGS

New Sentri-Seal...on guard against dirt and wear!

The unique design of the Sentri-Seal gives optimum protection against dirt, and includes a number of other major advantages.

Sentri-Seals are quickly removed, easily replaced. As the seal is of synthetic rubber, in which two metal rings are embedded, a constant-rate spring is created between the rings. Inherent flexibility prevents distortion of the bearing outer ring due to seal insertion, permitting the use of bearings to the higher accuracy specifications. The spring action maintains an efficient sealing contact with the bearing ring to bar dirt and retain lubricant. Sentri-Seals are relatively inert to oils and greases and operate satisfactorily through a temperature range of −40°F to 225°F. Specifications available for still higher temperatures. In applications where relubrication is desired, it is easily accomplished by the injection method.

The New Departure Sentri-Seal basically consists of two separate metal rings, "A" and "B", embedded in synthetic rubber, resulting in a spring which absorbs distortion and deflection. The seal is not drastically influenced by axial displacement due to bearing end-play within prescribed tolerances, and provides efficient sealing at low torque. Bearing shown is equipped with two seals.

ONE SENTRI-SEAL

SEAL AND SHIELD

SEAL AND SNAP RING

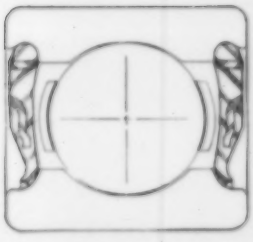
TWO SEALS AND SNAP RING

SEAL, SHIELD AND SNAP RING

The diagram shows in section the New Departure Sentri-Seal. Lip contacting surfaces are form-ground simultaneously with the ball race, giving an extremely high degree of concentricity between sealing surfaces and the raceway.

Sentri-Seal is available for a range of sizes in single-row, standard-width bearings and also in two types of New Departure adapter bearings. Sizes, dimensions and capacities are listed in the latest New Departure catalog.

Write for full details on Sentri-Seal



NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN.

Engineering News Roundup

Ship Drive Features Precision Gears

Giant Gear Train Made to High Accuracy

Double-reduction gearing for a new 25,200-ton Dutch tanker consists of single-helical gears. All the gear teeth have precision ground profiles, a feature said not usually found in machinery designed for this type of service.

Designed by Maag Gear-Wheel Co. of Switzerland, the gear assembly weighs 55 tons and supplies a maximum of 10,890 shaft horsepower at 111.5 rpm. Service rating is 9900 shaft horsepower at 108 rpm.

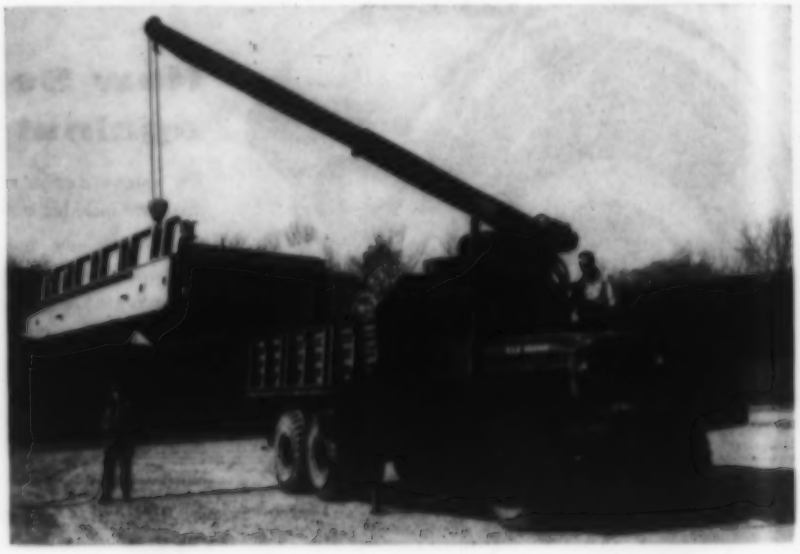
Three turbines are coupled to the reduction unit, the smallest of the first-reduction pinions being 8.11 inches in diameter. All three of the second-reduction pinions are 18.35 inches in diameter and mate with a main or "bull" gear 118.27 inches in diameter. Face width of the main gear is 18.5 inches; tooth loading is 1859 lb per inch.

First and second-stage pinions and first-reduction gear wheels are of nickel-chrome case-hardened steel. Main gear is of nickel-chromium-molybdenum heat-treated steel.

Start Design of First U.S. Commercial Turboprop

Three-Year Program to Produce Faster, Quieter Planes

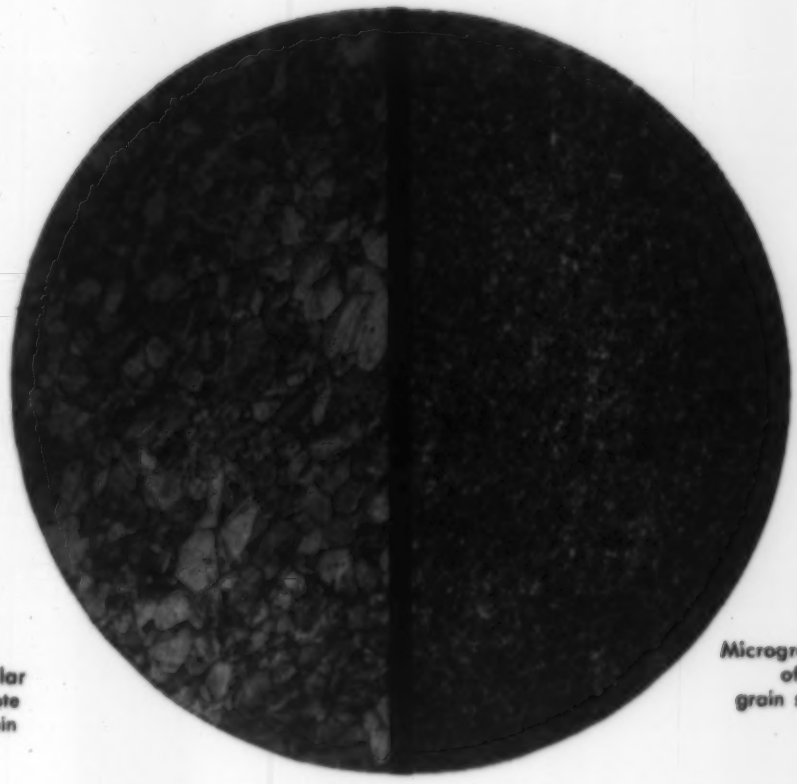
Turboprop-powered commercial airliners, gaining in popularity because of their speed and vibration-free characteristics, will soon be



EXTRA ACCESSORIES for Army trucks include these new devices recently developed by the Corps of Engineers' Research and Development Laboratories. A hydraulic boom, above, consists of two telescopic box sections mounted on a column near the backboard of the truck. The boom, 16 ft long, can be swung through an angle of 220 degrees. Hydraulic power is furnished by a pump driven by the truck's engine. A 20-ft long A-frame, below, is fabricated of standard steel shapes. Its lifting power is supplied by the truck winch

Get longer life in formed parts AT NO EXTRA COST

USE THE NEW FINE GRAIN PHOSPHOR BRONZE WITH 30% GREATER ENDURANCE LIMIT



Micrograph (75x magnification) of regular phosphor bronze. Note relatively coarse grain structure.

Micrograph (75x magnification) of Duraflex. Its fine grain structure is the secret of its superiority.

DURAFLEX*

BY ANACONDA

DURAFLEX is a new, fine-grain phosphor bronze developed and sold only by Anaconda. Comparative fatigue tests show that the endurance limit of DURAFLEX is approximately 30% higher than for regular phosphor bronzes. In surface appearance, surface smoothness and hardness, it is superior to other phosphor bronzes. It is unsurpassed in corrosion resistance by any other phosphor bronze. Further, its formability is increased with no sacrifice in yield strength. DURAFLEX is a *premium* phosphor bronze in every way except cost; there's *no increase in price.*

If you're now using a hard-temper phosphor bronze, chances are that you can do the same forming in extra-hard temper DURAFLEX.

If you're looking for longer life in the parts you form, we'll be glad to send you a free sample of DURAFLEX. Try it, test it, and you will agree that it is superior. 5081

*Trade Mark

SEE FOR YOURSELF—

AN

ANACONDA®

PRODUCT

MADE BY THE AMERICAN BRASS COMPANY

FREE SAMPLE

The American Brass Company, Waterbury 20, Conn.

(In Canada: Anaconda American Brass Ltd., New Toronto, Ontario)

Yes, we'd like to try DURAFLEX. Please send us a free sample of

sheet in _____ temper, _____ thick,

wire in _____ temper, _____ diameter.

☐ **We'd like to talk to one of your representatives about DURAFLEX.**

NAME . . . . . .

COMPANY . . . . . .

STREET . . . . . .

CITY . . . . . STATE . . . . . .

SHEET . . . up to 0.062" thick

WIRE . . . up to 3/16" diameter (approx.)

rolling off U. S. production lines. A recent announcement by Lockheed Aircraft Corp. disclosed the start of a 39-month program to produce the first United States turbine-propeller powered commercial airliner.

First flight of the new four-engine plane, to be called the Lockheed Electra, is scheduled for October, 1957. First customer delivery is planned for August, 1958. A total of 35 planes will be produced initially for American Airlines.

According to Lockheed, top speed of the Electra is expected to be about 450 mph with a 2000 mile range. Cruising speed will be about 415 mph. Allison 501 turbine engines, rated at 3750 hp each, will probably power the first models. However, the plane is being designed to accommodate engines rated as high as 5000 hp. Final decision on the power plant has not yet been reached.

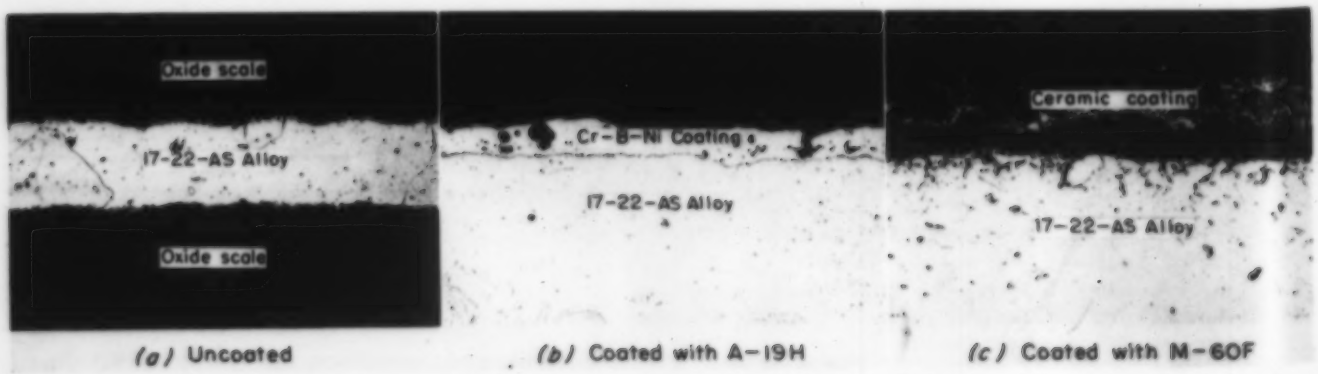
Wingspan of the 90-passenger aircraft is to be 95 ft. Height of the plane will be 34 ft and its overall length will be just over 101 ft. Maximum takeoff weight will be about 98,500 lb.

GOLF BALL RADIO pictured here makes possible a theoretically nonloseable golf ball. Transistor powered, the miniature transmitter was designed by Motorola. Its transmitted signal is strong enough to be picked up by the transistorized pocket receiver shown in the background. A lost ball is found by rotating the receiver like a direction finder. Motorola emphasizes that the device is strictly a "gadget" and is not for sale in sporting goods stores. Although the golf ball will bounce when dropped, there's some question whether a solid 250-yd drive will leave it intact

Cermet Coatings Applied By Ceramic Procedures

New Mixture Promises Wider Application Range

Ordinary ceramic coating procedures are being used by the National Bureau of Standards to apply a cermet coating to a metal base. The process is said to replace the former flame spraying method to provide a hard, high-temperature-resistant facing for metal parts. The cermet powder being used is a chromium-boron-nickel mixture combined with a



New cermet coating developed by the National Bureau of Standards has excellent high temperature resistance. Comparison of three low-alloy steel specimens after heating in air at 1500 F is shown. Specimen *a* is uncoated, specimen *b* is coated with an all-ceramic coating and specimen *c* is coated with the new cermet powder. Protection provided by the all-ceramic coating was not as good as that provided by the new cermet

Kennametal tools working in a coal mine.

OSTUCO TUBING HELPED BOOST PRODUCTION AND REDUCE DRILLING COSTS

The Problem: Various mining augers originally used with Kennametal Tungsten carbide bits were frequently replaced due to bending and twisting—particularly in hard, fast drilling. This resulted in excessive downtime, and limited potential drilling life of the Kennametal bits . . . which are capable of drilling from 4,500 to 12,000 feet.

The Solution: New Kennametal augers, manufactured from OSTUCO Seamless Steel Tubing, last the life of several bits. These tubular augers have rigidity to stand the high pressure of fast, long-hole drilling, yet are light weight for easier handling underground. Lightness, rigidity and long wear are especially important in drilling holes of 100 feet depths during mining of anthracite coal and gypsum.

Discuss your particular problems with an OSTUCO Tubing Engineer. Then take advantage of OSTUCO's convenient *Single-Source* Service and fill all your tubing needs on one order. Write or call your nearest OSTUCO Sales Office, or write OSTUCO, Shelby, Ohio.

OSTUCO TUBING

SEAMLESS AND ELECTRIC WELDED STEEL TUBING
—Fabricating and Forging

OHIO SEAMLESS TUBE DIVISION
of Copperweld Steel Company • **SHELBY, OHIO**
Birthplace of the Seamless Steel Tube Industry in America

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ceramic frit. The resulting coatings are said to have excellent thermal shock resistance and are reasonably ductile.

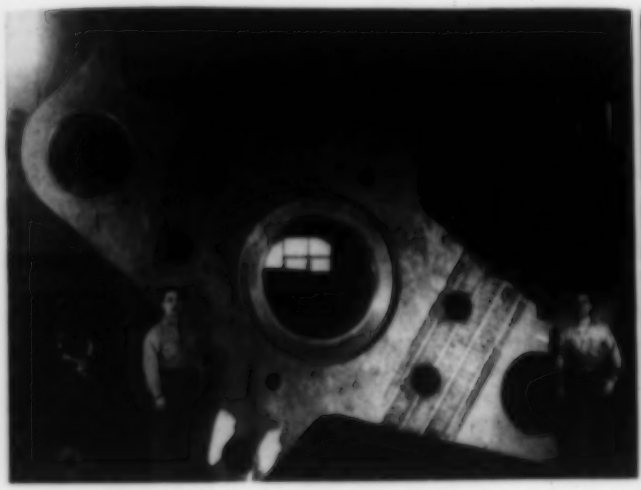
Flame spraying, according to NBS, is expensive for large-scale production and is not suited to the coating of cylindrical parts of small diameter. Neither is it feasible where thin layers of about 0.002-in. thickness are required.

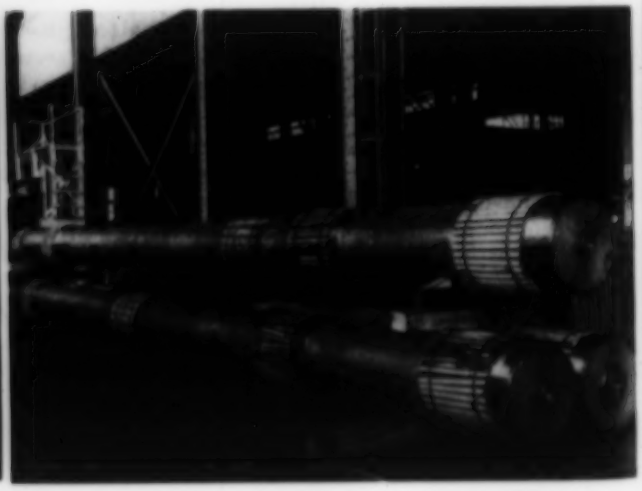
In the NBS process, a slip is prepared from a cermet powder and a ceramic frit. However, instead of flame spraying the material, the usual ceramic coating procedure is followed and the slip is applied to the metal part at room temperature by either dipping or spraying. The part is then fired at a temperature above the melting point of both the cermet and the frit.

During the firing, the ceramic phase in the coating serves as a flux to permit welding of the cermet particles without necessity of a highly-purified, oxygen-free atmosphere. Depending on the firing temperature, the ceramic material either "sweats out" to the surface or remains as occlusions in the cermet network. The cermet particles melt to form a continuous layer that becomes brazed to the surface of the metal.

In a series of experiments with different ratios of frit to cermet powder, NBS researchers found that firing time had little effect on

NUCLEAR BATTERY that converts nuclear energy into electrical energy is capable of delivering up to 10,000 volts. Current ratings at lower voltages are up to 2 milliamperes. Disintegration of Strontium 90 is the energy source, according to the battery's makers, Patterson-Moos Research Div. of Universal Winding Corp. Model at the left is a multiple voltage source. The smaller battery on the right supplies 10,000 volts at 5 micromicroamperes





GIANT PRESS for use in extruding large aluminum sections is being built by Lombard Corp. for the Air Force. Shown here is the crosshead, left, and the threaded main columns. Each column weighs 50 tons. Having a capacity of 12,000 lb, the machine is designed to use aluminum billets with a maximum diameter of 32 inches and a maximum length of 70 inches. Design of the machine makes it adaptable for use with other metals, both ferrous and nonferrous. Five 800-hp motors drive the main pumps. Pumping capacity of the main hydraulic system is 1800 gpm at 4500 psi

NO SIDE LINE

BOUND BROOK'S

MAJOR PRODUCTS ARE

THE WORLD'S FINEST

POWDER METALLURGY

BEARINGS AND PARTS

the appearance of the coatings. Firing in air gave satisfactory coatings on alloys that initially had good oxidation resistance. However, a furnace atmosphere of low oxygen content was necessary to achieve satisfactory protection on such metals as molybdenum, ingot iron, and several low-alloy steels.

Neither thorough cleaning nor roughening of the metal surface prior to applying the coating was essential. Satisfactory coatings were obtained on smooth surfaces which had been only mildly degreased before applying the slip.

AGMA Index shows volume for the gear industry to be increased by 14.1 per cent in May, 1955, as compared with April, 1955. The index figure for May, 1955, is computed to be 205.2. AGMA index figures are computed using the 1947 to 1949 period as a base of 100.

Corrosion Research Council has been proposed by the Engineering Foundation to study metallic corrosion. Purpose of the group will be to (1) increase fundamental scientific data, and (2) increase cooperation among scientists in electrochemistry, physical metallurgy, solid-state physics, nuclear physics, surface chemistry and physics, reaction and others. Further information may be obtained from the Engineering Foundation, 29 West 39th St., New York 18, N. Y.

Military Helicopter To See Commercial Use

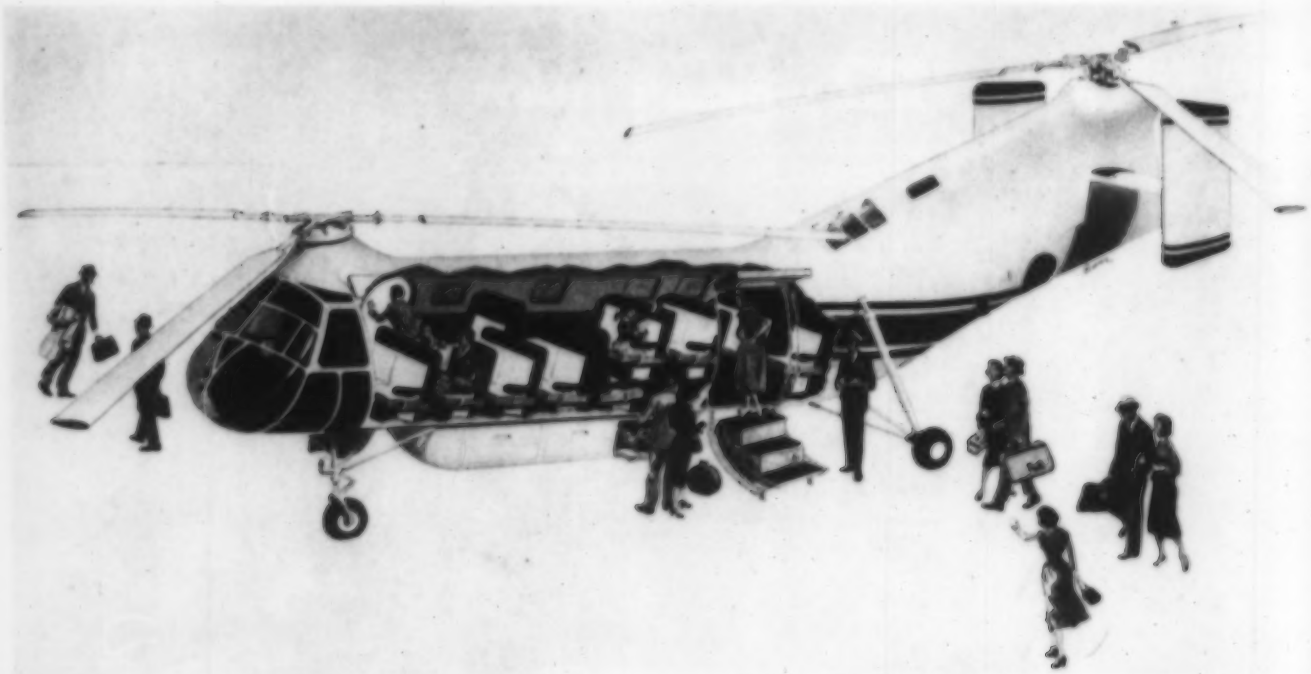
Twin-Rotor Craft To Be Adapted for Airline Service

A commercial version of a twin-rotor helicopter, now in use by the Air Force, is to be adapted to civilian use. Redesign of the interior will permit accommodation of up to 19 passengers, according to Piasecki Helicopter Co., designers of the craft. The passenger cabin will be 20 ft long, about 5½ ft wide and 6 ft high.

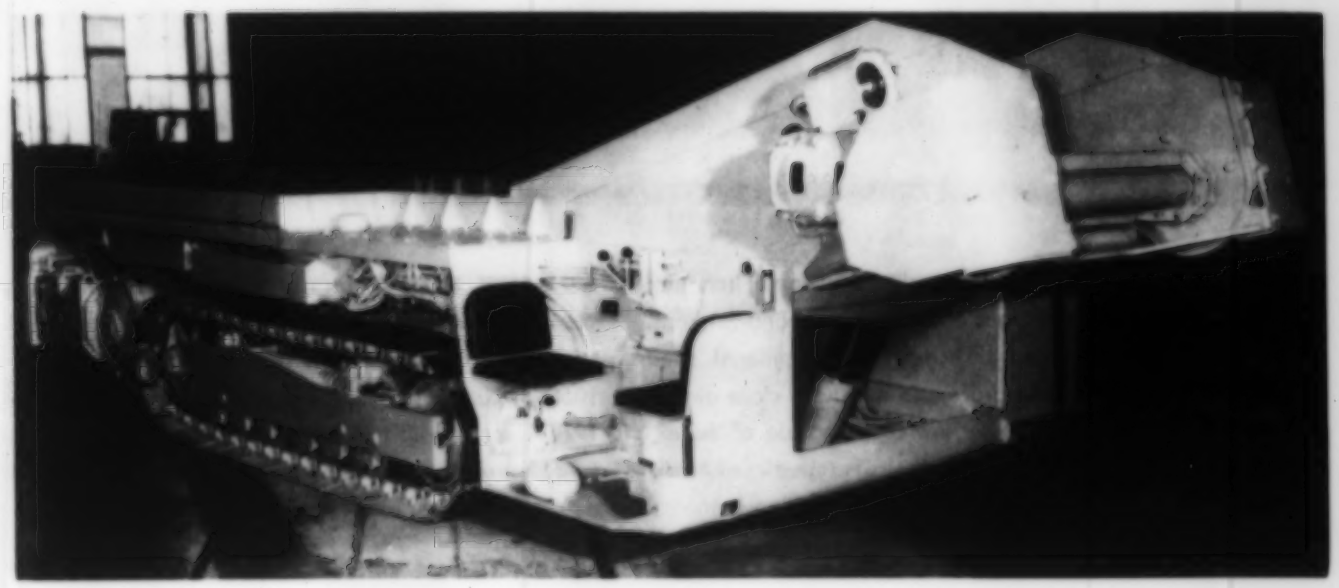
Top speed of the military version is 131 mph with a normal cruising speed of 98 mph. A 9-cylinder Wright Cyclone radial engine develops 1425 hp on takeoff. Gasoline consumption is 69 gallons per hour and the cruising range is 338 miles. Service ceiling is 9450 ft. These specifications will also apply to the commercial model.

Because of the twin rotor design, passengers may sit anywhere with no regard for balance. Rotor blades clear the ground by 14 ft, making loading possible while the rotors are idling. Trucks may also drive up to load or unload mail or cargo while the rotors are turning.

For passenger service, two loading doors will be provided to reduce ground time. However, the craft is adaptable to carry fewer passengers and more cargo by dividing the compartment. A detachable pack may be mounted under the fuselage to accommodate additional cargo.



Commercial version of the Air Force tandem-rotor Piasecki helicopter will seat up to 19 passengers. Doors on both sides and built-in steps speed loading and unloading. An external compartment under the plane accommodates extra baggage. More cargo space may be obtained by rearranging the cabin



LOW-DOWN CAR designed for mine haulage service is only 43 inches high. A caterpillar track system permits a turning radius of 14 ft. Made by General Electric Co., the car is powered by two 20-hp traction motors. Two 5-hp motors power the hydraulic system pump. Other new design features include a simplified controller system with rotary switches, a new type conveyor motor and an improved track carriage frame. Hauling capacity is 8 tons

Titanium Brazed At Lower Temperatures

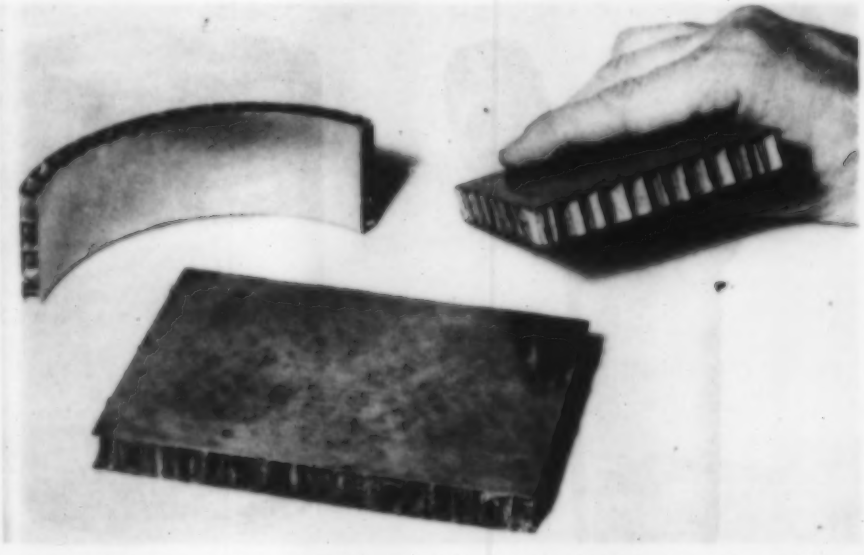
Vacuum Process Permits Brazing Without Distortion

Titanium assemblies may be brazed at lower than normal temperatures by a newly announced vacuum process. Silver or silver manganese brazing alloys can be used to fabricate an all-titanium alloy assembly. Titanium may also be joined to stainless steel or other alloys.

No fluxes are required and simultaneous brazing operations are possible. The process is said to minimize distortion, embrittlement and other difficulties normally associated with high-temperature brazing.

In processing an assembly, the parts are put together with brazing alloy shim strips between pieces. After weighting them to assure good contact, the assembly is placed in a retort. The retort is then placed inside a vacuum furnace where the actual brazing takes place. Assemblies of any size may be brazed.

Developed by Stainless Processing Div. of Wall Colmonoy Corp., the process is said to be applicable to brazing such items as titanium alloy turbine blades. It is said especially applicable where complete brazing of upper joints is difficult to achieve, such as honeycomb sandwich sections.



Curved titanium sections, like the one shown, can be brazed without distortion by a new vacuum brazing process, according to Wall Colmonoy Corp.

New aluminum alloy, designated 5083, has been announced by Kaiser Aluminum & Chemical Corp. It is a non-heat-treatable alloy that can be welded at high speeds. Inert-gas arc welds are reported to have an ultimate tensile strength of 42,500 psi. Applications for which 5083 was designed include welded

(*Continued on Page 24*)

ARMASTEEL

ArmaSteel is a versatile pearlitic malleable iron that combines the advantages of both castings and forgings. ArmaSteel parts can be cast by conventional sand method or shell mold process to relatively close dimensions in large quantities at low cost. Because of the excellent, accurately controlled physical properties of ArmaSteel, these parts have the strength and performance characteristics usually associated with plain carbon steel forgings.

ArmaSteel is produced in three ranges: ArmaSteel 84M, ArmaSteel 85M and ArmaSteel 86M with a wide variety of physical properties uniformly maintained through accurate heat treating operations as follows:

ARMASTEEL 84M is recommended where a high degree of strength is necessary. It usually replaces heat-treated steel parts in the 1040-1050 S.A.E. range. It has a hardness range of BHN 241-269 or 3.7-3.9mm. impression with a 3000 Kg. load. Tensile strength is 100,000 p.s.i., yield strength is 80,000 p.s.i., and percent of elongation in 2" is 2.0%.

ARMASTEEL 85M is recommended where moderate strength is required and where selective hardening is necessary. This class usually replaces parts in the 1035-1050 S.A.E. range. It has a hardness range of BHN 197-241 or 3.9-4.3 mm. impression with 3000 Kg. load. Tensile strength is 80,000 p.s.i., yield strength is 60,000 p.s.i., and percent of elongation in 2" is 3.0%.

ARMASTEEL 86M is recommended for less highly stressed parts usually replacing steel parts in the 1020-1035 S.A.E. range. It has a hardness range of BHN 163-207 or 4.2-4.7 mm. impression with 3000 Kg. load. Tensile strength is 70,000 p.s.i., yield strength is 48,000 p.s.i., and percent of elongation in 2" is 4.0%.

MACHINABILITY OF ARMASTEEL

ArmaSteel's machinability makes it outstanding in the ferrous field. In general, its rating is from 10% to 30% better than bar stock or forgings of the same Brinell hardness. One of the reasons for this rating is the structure, which consists of a matrix of sorbitic- pearlite and spheroidized cementite in which small nodules of carbon

a triumph of modern metallurgy

are imbedded. Because of this the chips break off more readily in machining operations whether it be turning, drilling, milling or broaching.

The machinability rating of a metal is not absolute—its rating can be stated only in relation to that of another metal. To establish the accompanying machinability rating table Bessemer screw stock S.A.E. 1112 is used as the base. In establishing these ratings, the cutting speed of the S.A.E. 1112 is the rate generally used in turning this metal on automatic screw machines. The rate of feed, however, is altered to that necessary to attain normal tool life and good surface finish when using a coolant. When the other metals are tested, the feeds and speeds are varied from these basic rates to whatever rate is necessary to obtain comparable tool life and comparable surface finish. The ratio of these rates of speeds and feeds of each tested metal determines the percentage of machinability.

The FIVE parts illustrated below are typical of the hundreds of different parts and products successfully produced in ArmaSteel for many diversified industries.

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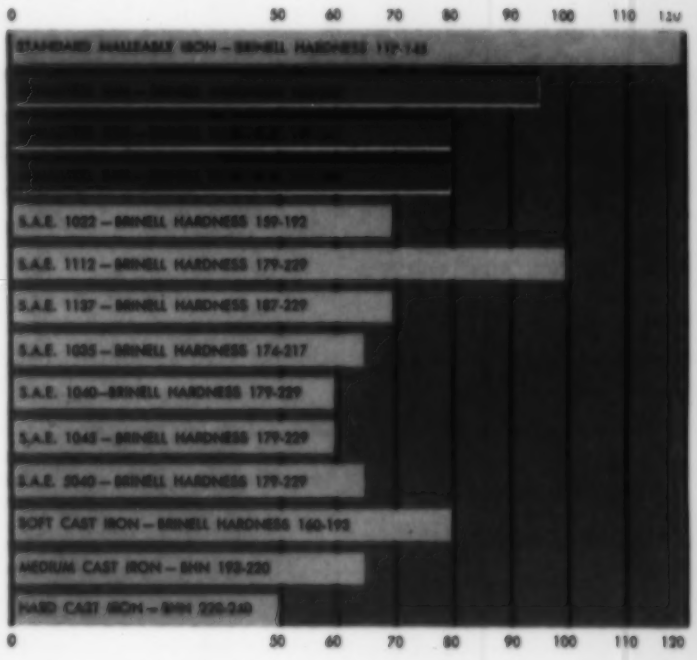
MACHINABILITY RATING (PER CENT)



CENTRAL FOUNDRY DIVISION · GENERAL MOTORS CORPORATION

50-A

CENTRAL FOUNDRY DIVISION
GENERAL MOTORS CORPORATION
SAGINAW, MICHIGAN

(*Continued from Page* 21)
structures requiring maximum joint strength and efficiency plus light weight and corrosion resistance.

Transparent Overlays Save Drafting Time

New Technique Combines Reusable Film Positives

Valuable time can be saved in the preparation of drawings by using a series of positive film overlays to make positive prints. Devised by the General Electric Medium Voltage Switchgear Dept., the system is said to save up to 95 per cent of the time needed to make engineering drawings.

Heart of the system is a series of transparent film positives. Each positive contains one particular part of a drawing. By combining these various film overlays, a print is made containing all of the required information.

In practice, the engineer or draftsman specifies a drawing by a particular code number. Film overlays corresponding to the

Conference on Mechanisms Planned for Next Spring

The Third Conference on Mechanisms is scheduled for May 24 and 25, 1956, on the campus of Purdue University. Sponsored by the Purdue School of Mechanical Engineering and MACHINE DESIGN, the conference will be open to all engineers and others interested in the problems of controlled motion. Plans are underway for a full two-day program of technical papers, roundtable discussions, and other events.

Previous two conferences were held at Purdue in the Fall of 1953 and 1954, respectively. The Spring date for the Third Conference will avoid the succession of engineering meetings and expositions which continue this Fall almost without a break from the Machine Tool Show in September through the ASME annual meeting in mid-November. Full details of the Third Conference, including program and registration information, will be published in MACHINE DESIGN well in advance of the meeting.

Electronic Computer Determines Machinability

Calculator Gives Answers Based on Machining Variables

Correct conditions for machining a certain job can be determined with a new electronic calculator. Information on 13 of 14 machining variables are fed into the unit. The device comes up with the 14th variable, the answer.

Developed by General Electric Co., the analog unit gives answers based on the grade of metal, speed, feed, depth of cut, tool life, alloy, material hardness, etc. It also considers five variables affecting motor horsepower required to do the machining.

Answers provided by the computer are based on the use of the preceding variables including tool geometry which will result in a normal wear type cutting edge failure. Machining problems formerly requiring several hours to compute can now be solved in a few minutes according to General Electric. Accuracy and consistency of results are said to be good.

Yours for the asking

There's no sense in even *trying* to be an expert in *all* phases of manufacturing today. And there's no need to. For your specialized motor problems, you can turn to Leland's competent sales and design engineers — experts you can "add to your staff" *for the asking.*

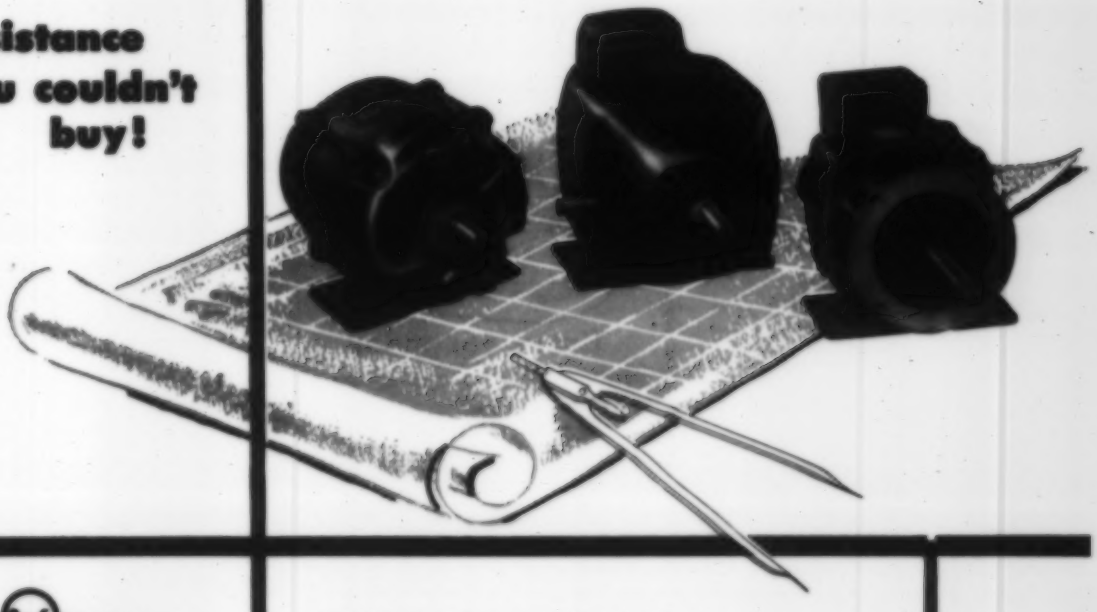
With years of practical experience in serving manufacturers, and a finger-tip knowledge of Leland designs and applications, our representatives can often give you an immediate recommendation. They may confer with our capable staff of skilled design engineers. Often, the design engineer will wish to discuss the problem directly with you, to obtain all the pertinent data needed for a thoroughly practicable solution.

For more than 30 years, Leland has been a leader in the design and manufacture of unusual motor items. And though it has been a constant challenge, sometimes a seemingly impossible one, the reward has been the regularity with which Leland has come up with the answer.

Today, the complete line of Leland motors, standard or special, reflects the wealth of design know-how acquired through developing units for so many widely diversified applications.

Try Leland on *your* motor requirements, from ¼ to 5 hp. Profit from Leland's experience and the in-built quality of its standard motors. Or consult our representatives in principal cities about your *special* motor problems. Add a real specialist to your staff.

Design assistance you couldn't buy!



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LELAND MOTORS

THE LELAND ELECTRIC COMPANY
Division of American Machine & Foundry Company
Dayton 1, Ohio

Visit Leland at Booth 349,
Production Engineering Show, Navy Pier,
Chicago, September 6-16

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The Higher the Pressure
The Tighter the Seal—
that's the story with

ANCHOR
FLANCO
4-Bolt,
Split-Flange Couplings

Write for Anchor Catalog 55 S.F. and get all the facts.

— The static "O" ring seal eliminates the use of gaskets, sealing compounds and tapered threads. The higher the pressure in the line — the tighter the "O" ring seals.
— You can disconnect and reconnect hose lines time after time without leaks — there are no threads to wear out, no tapered seats to groove.
— Cut your production costs — eliminate costly pipe threading operations and separate union and swivel connections.
— The patented design of ANCHOR'S Split-Flanges completely conform to S.A.E. Standards.

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Write, wire or telephone M. H. Rhodes, Inc., whenever you plan a product that can be improved by adding a reliable timer or time switch. A Mark-time engineer will be at your office or factory promptly — make available to you, without obligation, all Mark-time's research and development facilities.

M. H. RHODES, Inc.
Hartford 6, Connecticut

Timers for many Household Appliances

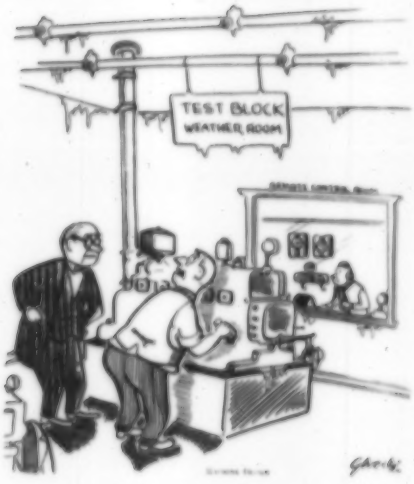
Famous Mark-Time timers and time switches fill a wide range of applications on leading brands of household appliances. Illustrated above is a built-in timer which provides accurate, on-the-spot timing for short-term mixing operations, and a bell signal to indicate "time's up!" This is just one example of the convenience, value and sales appeal Mark-Time can add to products for home use.

Manufactured and sold in Canada by SPERRY GYROSCOPE OTTAWA, LIMITED, 3 Hamilton St., Ottawa, Ontario, Canada

News Roundup

code are chosen by the Blueprint section. These overlays are combined in the printing machine and a composite print is made.

Combinations of film positives may make possible extremely large numbers of different prints in a short time, according to General Electric. Where 6 to 18 hours were required to make some tracings by conventional methods, the overlay process makes positive "tracings" in a few minutes.



"It runs perfectly at 40 below and 110 above, but it won't even start at a normal temperature."

Precision Castings Made with Glass Molds

New Method Designed For High-Temperature Alloys

Precision casting of metals with glass molds has been announced by Corning Glass Works. Designed especially for work with high-temperature alloys, the method is claimed to produce excellent surface finishes and maintain tight dimensional tolerances. Close regulation of metallurgical structure is possible because of the high temperatures at which the molds are used.

Called Glascast, the process eliminates the precoat step in investment casting. Cracking and spall-

ing are said to be reduced.

Essentially 96 per cent pure silica glass, the Glascast powder is mixed with water to produce a casting slip. After mixing, the slip is poured into a porous plaster mold and allowed to stand until enough water has been absorbed to build up a shell of glass solids to the desired thickness. Excess liquid is drained off and the slip is dried. After removal from the plaster form, the Glascast shell is oven dried, then fired for about half an hour at 1740 to 1920 F, depending on the strength desired. The mold is then ready for storage or for use.

Before casting, the mold is preheated to the desired temperature for about 10 minutes. Because of its resistance to thermal shock, Glascast can be fired without danger of cracking. Tolerances of ±0.005-inch can be held because of the low thermal expansion of the material.

Castings produced by the Glascast process are reported to have blemish-free surfaces of better than 40 microinch finish. Since the mold material has high chemical stability, it does not react with the metal or its oxides to cause surface imperfections. Accurate control of grain size is said possible at metal pouring temperatures as high as 3200 F.

In production tests of such items as jet engine buckets and vanes, not more than 10 per cent of the items were reported rejected because of imperfections. Any of the conventional casting methods such as static, pressure, centrifugal and vacuum are said to be suitable for use with the new technique. Aluminum, brass, carbon steels, stainless steels, cobalt base alloys, and chromium base alloys are among the metals that may be cast.

Mobile Power Plant Run by Gas Turbine

Railway Car Unit Designed For Emergency Use

Powered by a newly designed gas turbine, an emergency mobile power plant is being constructed for use by the U. S. Navy's Bureau of

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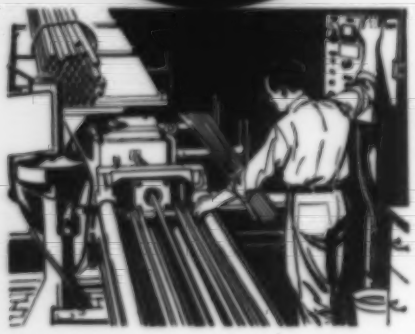

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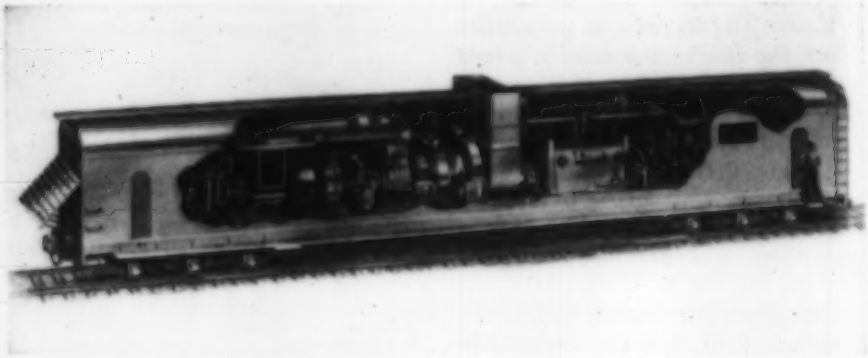
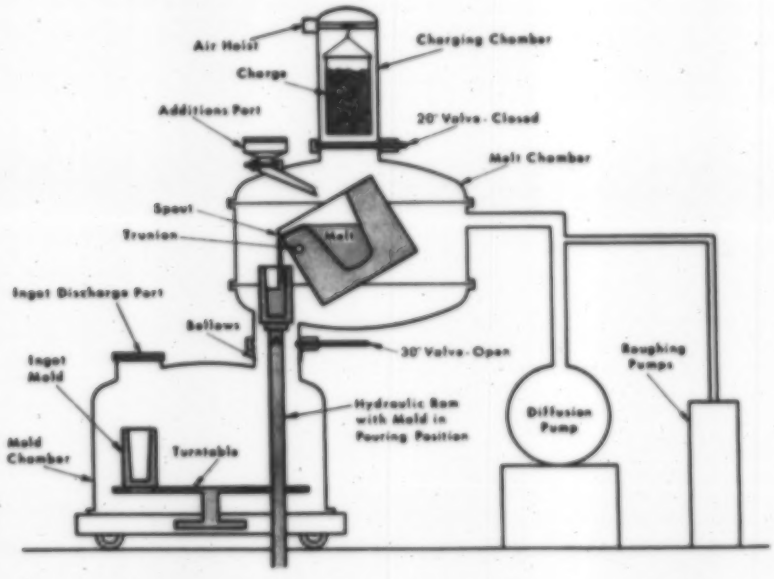


Cutaway view of the mobile turbine-driven power plant designed and being built by Clark Bros. Co. Mounted in a standard railway car, the plant will be able to provide emergency power within a few hours after arriving at the location

Docks and Yards. By mounting the unit in a single railroad car, it will be completely mobile and will be capable of being moved from place to place via high-speed railroad trains as conditions dictate. According to Clark Bros. Co., builders of the unit, the plant is designed to be ready for operation within a few hours after its arrival at the site.

Electrical output of the plant is



HOW IT WORKS: This drawing shows the General Electric 1000-lb vacuum furnace installation at the Carboloy Dept. in Detroit. Ingot molds are located in a large bell-shaped "jar" mounted on a platform that runs on tracks. The molds themselves rest on a turntable that forms the bottom of the jar. At pouring time, the jar is pushed into position and spotted under a 30-inch valve. The flange is raised to meet the 30-inch valve through a bellows arrangement.

After the connection is sealed, the jar is evacuated, the 30-inch valve leading to the induction furnace is opened, and the turntable in the bell jar indexes a mold into position. A hydraulic lift raises the mold through the valve into the pouring position in the main chamber of the vacuum furnace. After pouring, the hot ingot is lowered into the bell jar. The operation is repeated by indexing the bell jar

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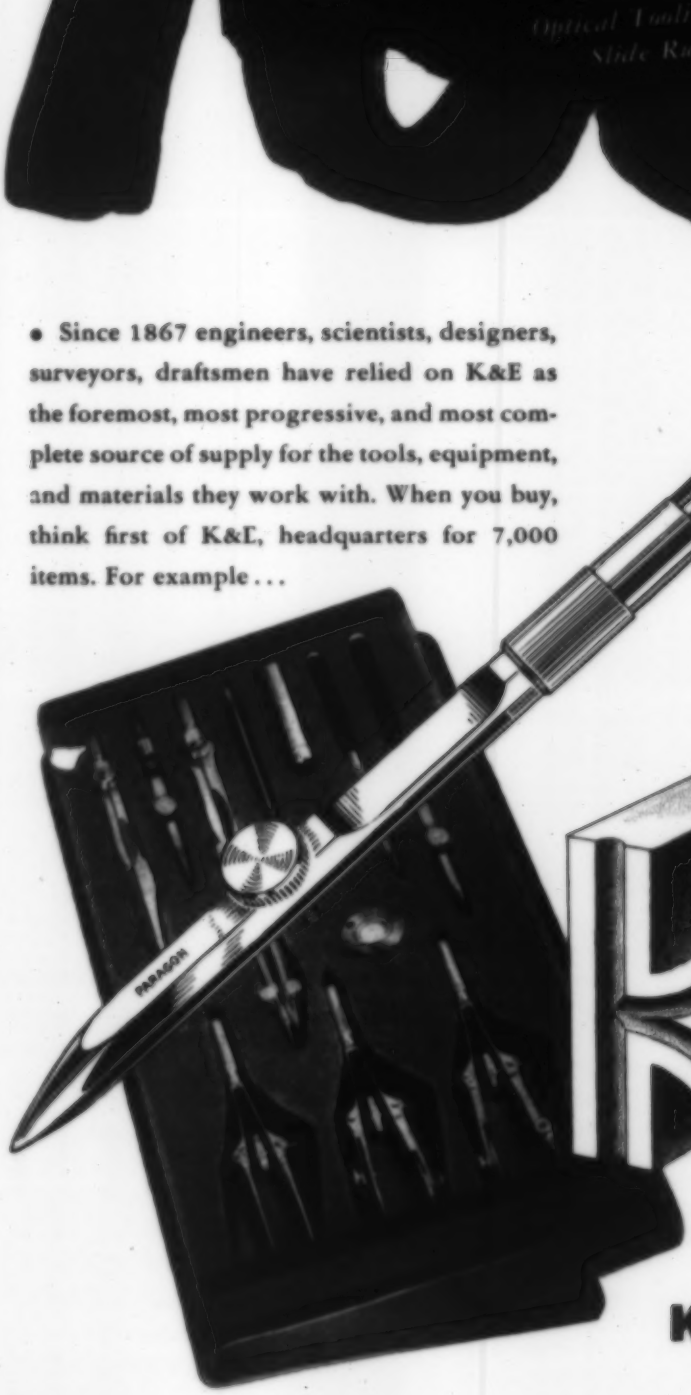

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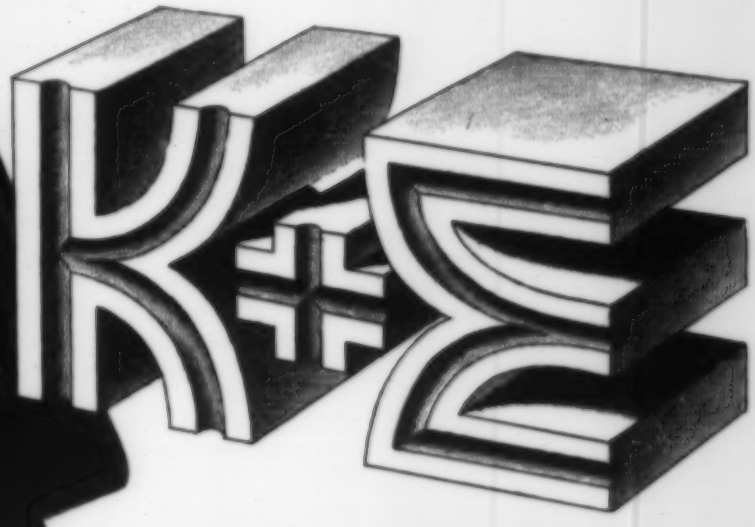

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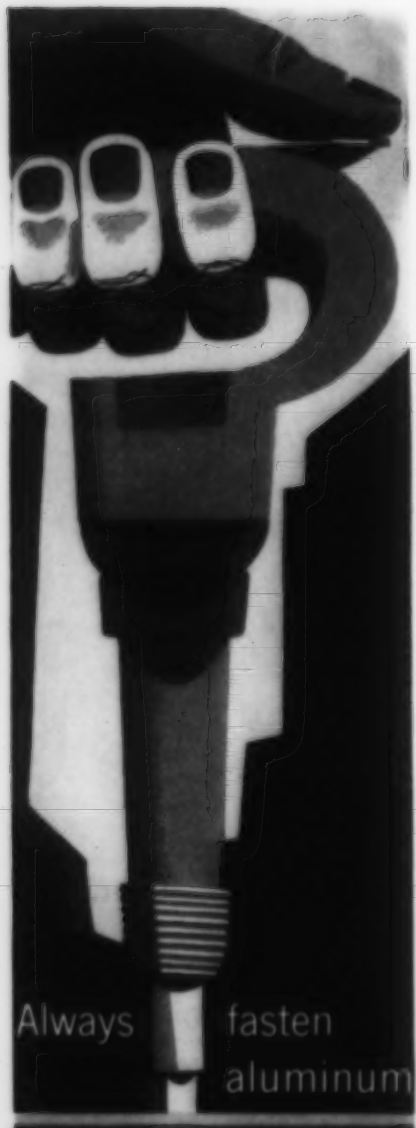

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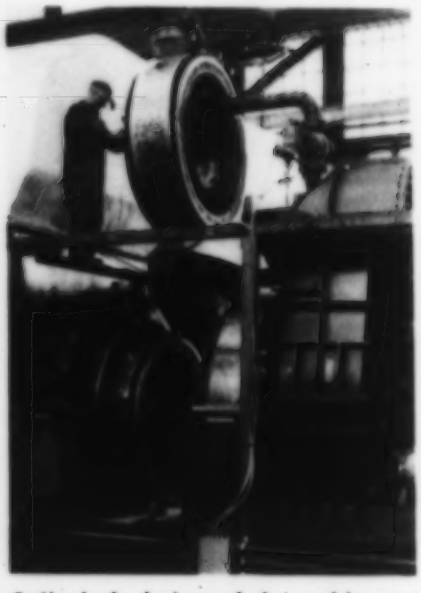
News Roundup

5500 kw. A two-pole generator is directly driven by an open-cycle, dual-shaft, series-flow gas turbine. An axial-flow turbine and axial-flow compressor make up the gas turbine unit.

Combustion air is supplied by the axial-flow compressor driven by the high-pressure turbine. The low-pressure turbine drives the generator at 3600 rpm.

Rotating blades of the turbine are forged and shrouded to reduce inter-stage losses. Precision-cast stator blades are attached to carrier rings with controlled clearances to permit thermal expansion without strain or distortion.

High and low-pressure turbines are mounted on separate bases and connected by a removable flexible duct. With the duct removed, ac-



Split-shaft design of the turbine assembly permits complete accessibility to the high and low pressure turbines of the Clark mobile power plant

cess is provided to both turbines for inspection or repair. Normal turbine operating temperature is 1350 F.

Three-point suspension is provided for each of the two mounting bases. This design permits normal car deflection without danger of shaft misalignment.

Cooling is with air introduced through openings on the inner diameter of the first stage stator ring. No water is required.

An auxiliary diesel engine is

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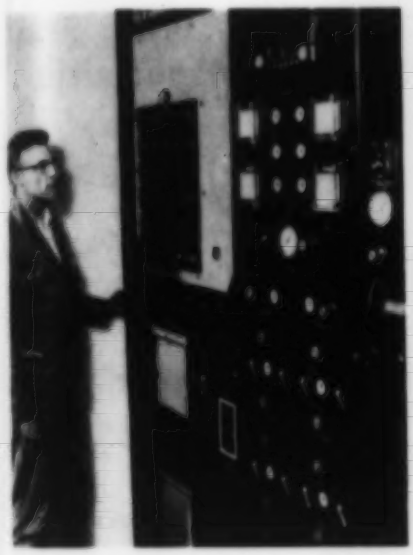
used to bring the turbine up to operating speed. When all start-up conditions are met, an indicator signals the operator to push the



Control panel of the railway-car mounted mobile power plant will be in a soundproof compartment. Controls are designed so the plant can be operated by one man

start button. The rest—ignition, ignitor airflow and fuel flow—is automatic.

Electrical output is obtained from a three-phase synchronous generator coupled to the turbine shaft through a flexible coupling. Output is 5500 kw at 12,500 volts.

Temperature detectors are imbedded between stator coils to enable continuous monitoring of operation. A lock is provided to hold the generator rotor during transit. Necessary transformers and associated switchgear are also mounted in the car to permit tieing the plant into outside power lines.

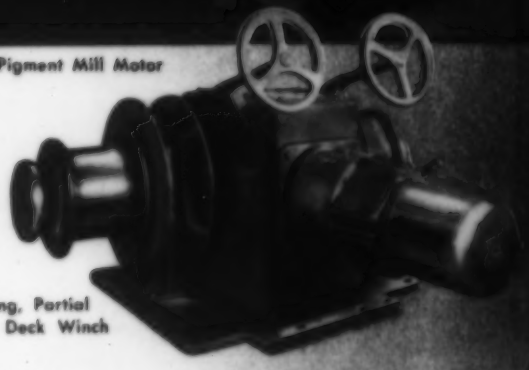
General Motors Powerama will be staged on the Chicago lakefront August 31 through September 25. Over 150 exhibits at the outdoor show will demonstrate uses and applications of diesel and gas-turbine power.

A lightweight, low-cost diesel-powered 400-passenger train, which reaches speeds of over 100 mph will be introduced. The XP-21 Firebird, first gas-turbine automobile,

(*Continued on Page* 36)

when it has to be RIGHT...

40 H.P. Imperial Special Pigment Mill Motor



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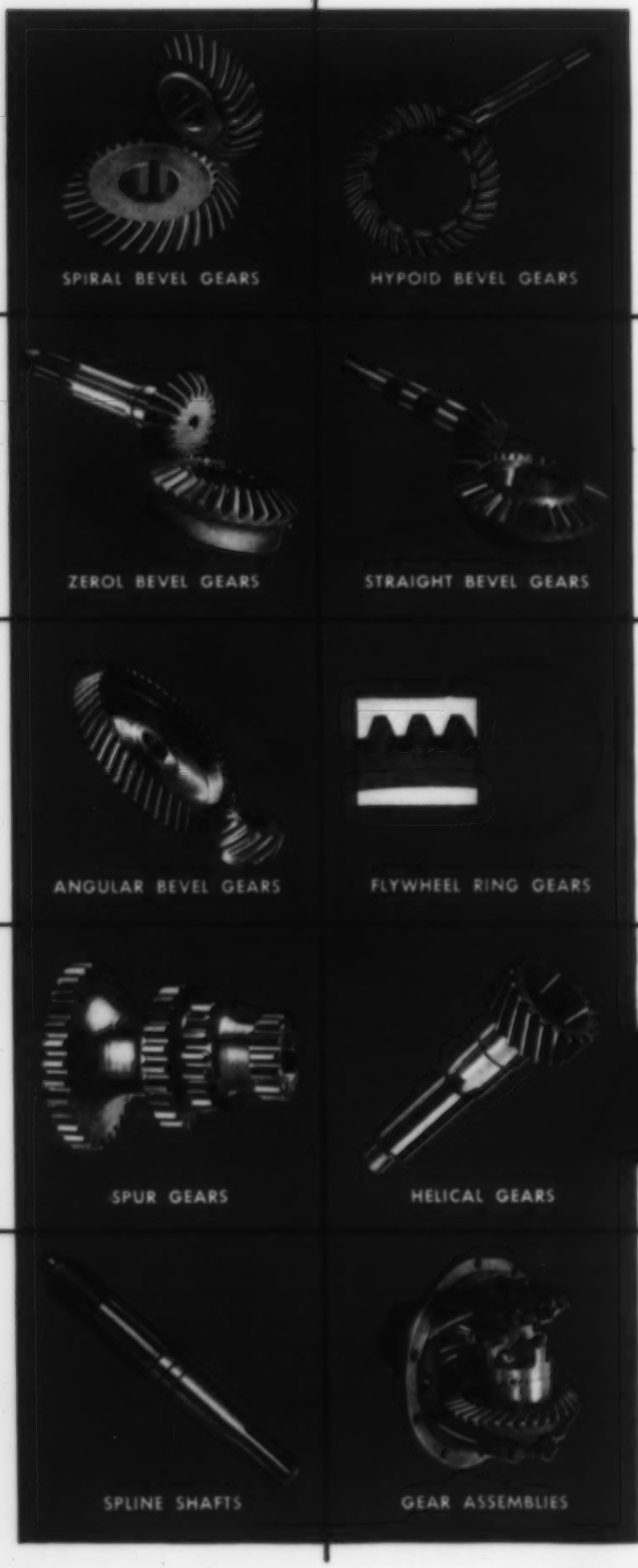

Through 40 years of gear making, these are the 10 gear types that have emerged as our specialties.

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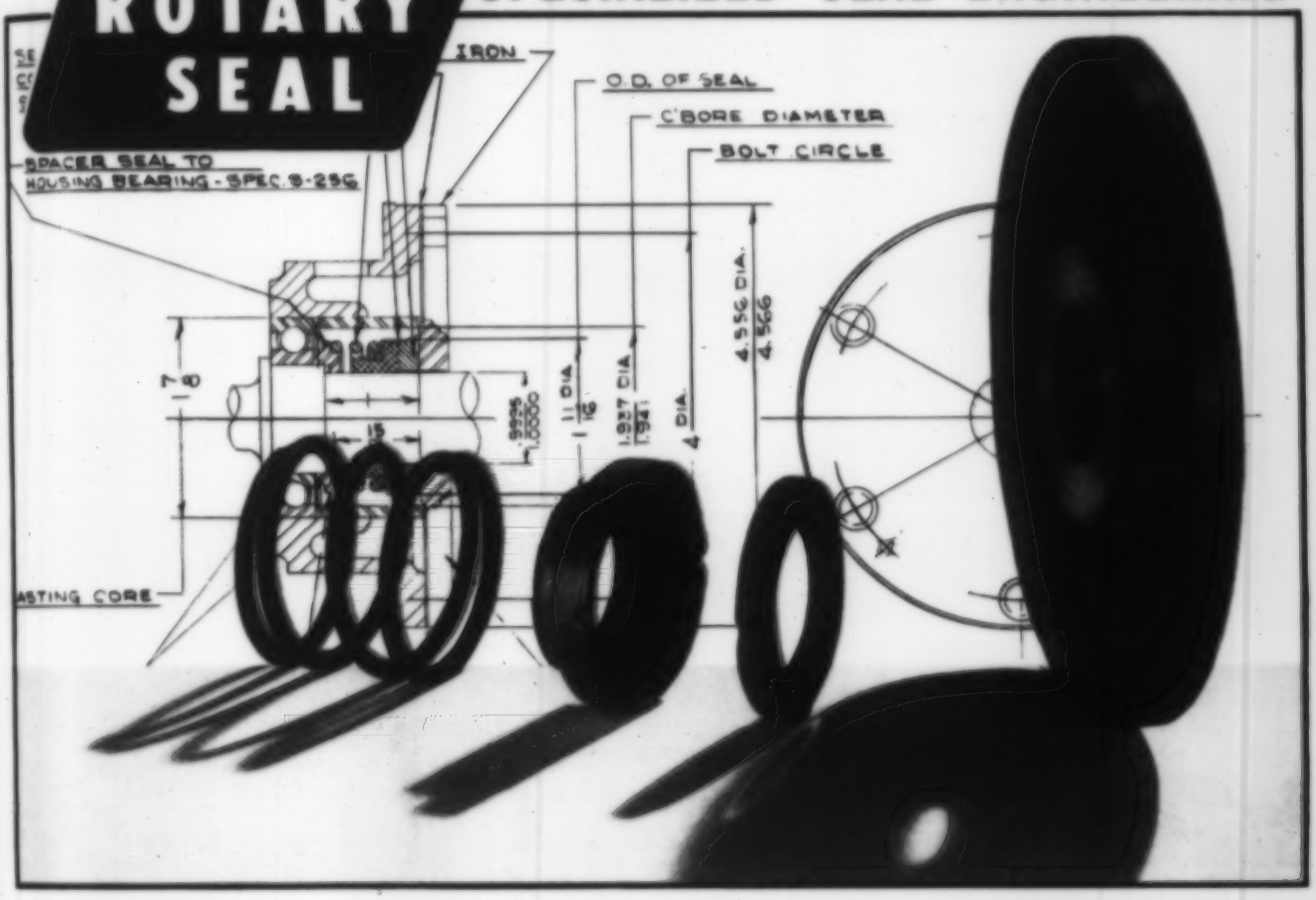

is developing new ways to assure top performance in AUTOMOBILE AIR CONDITIONING COMPRESSORS

Automobile air conditioning, a recent innovation, poses difficult new problems for the compressor maker. The Seal shown represents many months of designing effort, guided by years and years of specialized experience, to produce a Seal that's *right in every detail* — to assure steady unit performance uninterrupted by sealing difficulties.

This Seal, which has been developed for a leading manufacturer of compressors, well exemplifies the skill and patience of ROTARY SEAL engineering. That's our business — solving hard Shaft Sealing problems where production quantities of Seals are involved, by applying the basic ROTARY SEAL principles which opened the way to successful mechanical Shaft Sealing when this company introduced them years ago.

Major development programs in which we are now engaged prevent us from accepting new assignments at this time; but you'll find ROTARY SEAL ideas affecting the whole course of Shaft Seal design, as time goes by.

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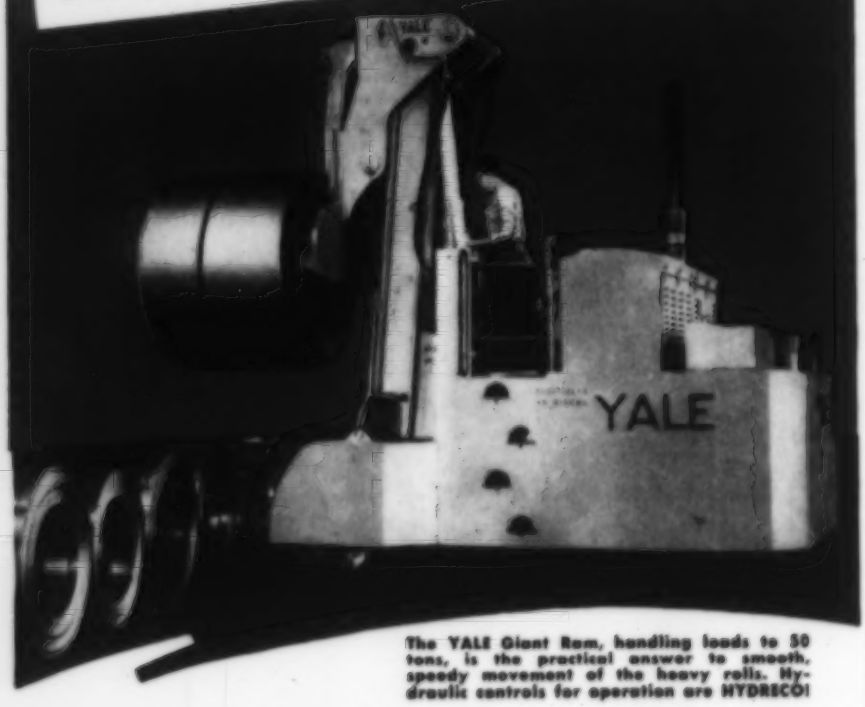
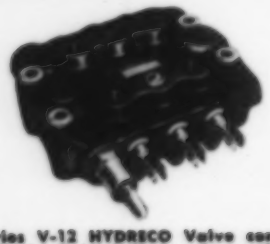


The YALE Giant Ram, handling loads to 50 tons, is the practical answer to smooth, speedy movement of the heavy rolls. Hydraulic controls for operation are HYDRECO!

But, It's Up and Away With a Flip of a Valve with HYDRECO Oil Power

Power for the Hoist Cylinder and adjustable forks of the YALE Giant Ram is furnished by a 3000 Series HYDRECO Pump.



Series V-12 HYDRECO Valve controls the Hoist Cylinder. An auxiliary HYDRECO Valve controls the forks.

The equipment that is "getting things done" today is more often than not equipped with HYDRECO Hydraulic Pumps, Motors, Valves and Cylinders. And, in engineering tomorrow's successful Materials Handling equipment, Farm Machinery, Heavy Construction and Earth Moving vehicles, the one outstanding attribute you will look for in components for the hydraulic system is —DEPENDABILITY. For years, the builders of equipment that "sells and performs" have used HYDRECO Oil Power. And, they have also drawn freely from the well of engineering "know-how" and experience which is here in HYDRECO. All are here for you, too.

WRITE— *for full information on new developments in HYDRECO Oil Power.*

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News Roundup

(*Continued from Page 31*)

and the Navy's "Pogo" vertical takeoff plane will be on display as well as an oil-drilling rig in operation, an operating sawmill and cotton gin. Other exhibits will include 50-ton dump trucks, tractors, road scrapers, huge generators and marine craft. Admission to the Powerama will be free.

Thompson Products Inc. has acquired Karl-Douglas Associates, designers of hydraulic and pneumatic cylinders and valves. Karl-Douglas will retain its identity and present location, operating as a division of Thompson's west coast plant at Bell, Calif.

New Design to Reduce Atomic Reactor Size

"Nesting" in Heat Exchanger Will Cut Weight and Space

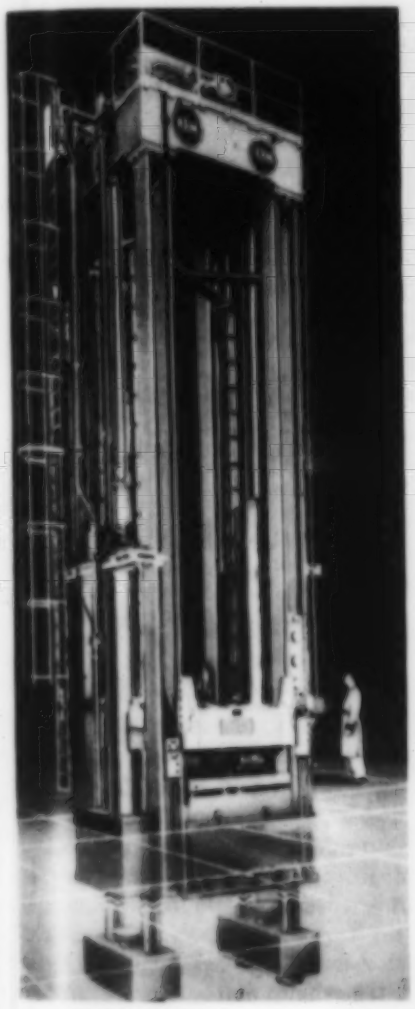
A proposed atomic reactor design is expected to reduce the weight per horsepower of conventional atomic reactors and eliminate many moving parts. Proposed by General Electric Co., the new design "nests" the reactor inside a cylindrical heat exchanger, thereby eliminating the need for a separate heat exchanger. Some piping and valves, which must be shielded to protect personnel from radiation, may also be eliminated.

Liquid sodium, the coolant, is to be pumped through the new reactor by electromagnetic means. Current generated by thermoelectric elements within the reactor itself will create a magnetic field. Action of the magnetic field will circulate the liquid sodium through a closed loop. Pumping rate is to be regulated by resistance units in the electrical circuit.

Reactor shielding is mainly responsible for most of the bulk and weight of present atomic reactors. The new design, according to General Electric, may make possible installations in aircraft and railway locomotives.

Dalmo Victor Co., San Carlos, Calif., has announced plans for

construction of a new building which will house all its present facilities. The firm designs and produces airborne radar antennas.



GIANT PRESS, said to be the world's largest, was constructed for molding reinforced plastics. Built by Hydraulic Press Mfg. Co., the press is 63 ft high and has a capacity of 600 tons. Platen size is 75 by 104 in.; stroke is 17 ft

Goodyear Aircraft Corp. is constructing a new engineering and research building in Akron, O. The new building will be equipped with instruments and facilities for research and development of new products in the fields of aerophysics and electronics.

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DUDCO PF-100 DUAL-VANE HYDRAULIC PUMPS

4 SIZES 3, 5, 8 and 11 gpm

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Today's production lines cannot afford avoidable machine breakdowns. DUDCO PF-100 Pumps, rated at 2000 psi for continuous operation, provide the extra margin of operating safety which your customers need so badly. The hydraulic system may not require more than 1000 psi — but the extra stamina provided by a 2000 psi DUDCO Pump cuts downtime AND more than doubles the life and dependability of the hydraulic system.

This added safety factor makes sense and saves dollars for the user . . . and at the business end of a sale, can make the deciding difference. You pay no premium for DUDCO 2000 psi continuous operation. They cost no more than pumps rated at considerably lower pressures. There's a DUDCO PF-100 Pump in a size and capacity and mountings to fit nearly all standard machine tools.

Users of machine tools can modernize and improve the dependability of their equipment with DUDCO PF-100 Pumps.

TWO VANES ARE BETTER THAN ONE

The hydraulically counter-balanced DUAL-VANES in DUDCO Hydraulic Pumps eliminate wear producing loads normally caused by unbalanced hydraulic forces and vane acceleration. DUAL-VANES also maintain MULTIPLE SEALING BARRIERS to slippage and power loss. DUAL-VANES are a patented and exclusive DUDCO feature.

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Mass Gear products are made to A.G.M.A. standards, thus insuring uniform quality.

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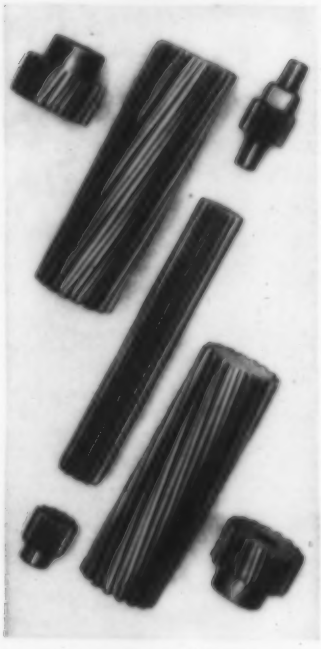

Massachusetts Gear & Tool Co.
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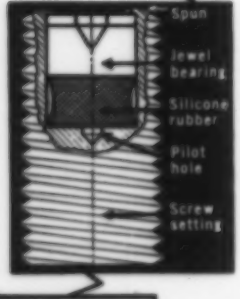
Be SURE of SHOCK PROTECTION for delicate instrumentation



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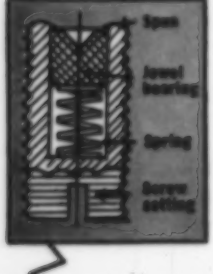

Bird Cushion Jewel Assemblies add the necessary safety factor to your instrument production, eliminating waste and tear-down because of poor judgment in bearing adjustment.

Let actual tests prove the superb performance of Bird Cushion Jewel Assemblies. Send specifications and sizes of jewel bearings you require. Bird will send you samples for testing in your own plant. Bird engineers are available for all your small bearing problems.

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20 Spruce Street, Waltham 54, Mass.

News Roundup

Miniature Blowers Feature Axial Flow

Compact Design Gives High Efficiency with Small Size

Miniature axial-flow blowers having high efficiencies have recently been developed. Designed by Plannair Ltd., the units are being manufactured by Pesco Products Div. of Borg-Warner Corp.

Smallest of the group is 1⅜ in. in diameter. Its driving motor is

less than an inch in diameter. Weighing about 8 oz, the unit delivers 16 cfm. Other blowers of the same design range in size to about 6 in. in diameter. Operating efficiencies are said to be considerably greater than conventional blowers of the same physical size.

The new units operate in any position and are designed for operation under severe conditions of shock, temperature, humidity, and altitude. They may be mounted in ducts and may be provided with totally enclosed or explosionproof motors.

Applications include aircraft ventilating, cooling electronic equipment, and spot heating. Marine applications may include fume removal and cooling high-powered signalling devices.

Machinery and Allied Products Institute has elected Charles W. Stewart Jr. of Washington, D. C., as president. He will also serve as chairman of the Council for

Technological Advancement, an affiliate organization of the Institute.

"That's Cogley—our gear expert."

Map-Making Film Available As Drawing Surface

Stable, Transparent Material Takes Ink or Pencil Drawing

High transparency and dimensional stability of a new drafting material make it suitable for full-size templates or optical comparator work. Release to draftsmen and engineers in private industry of the drawing surface material has been announced by Keuffel & Esser Co.

Called Stabilene, the material is developed from a polyester film with high tensile strength, high impact resistance and long flex life. Several types of coatings have been made for application to the film. These coatings include (1) Translucent surface to accept pen and ink drawings, (2) scribe coat for scribing, and (3) light-sensitive solutions including blueprint, brownprint, dry and moist diazo.

Among the advantages claimed for Stabilene over its predecessor glass cloth is its greater accuracy, lower cost and greater transparency. It is fiber free, which gives it a smoother drawing surface and eliminates the fiber pattern background on reproductions. It is also said to be more flexible and stronger than the glass cloth.

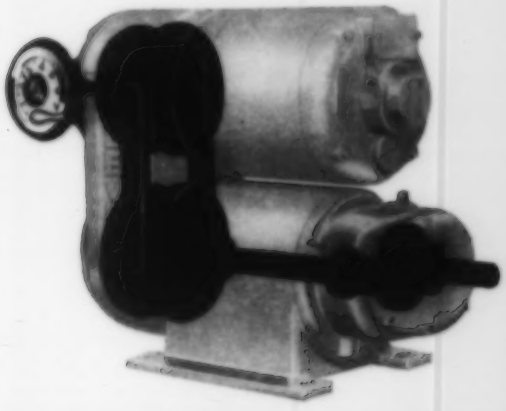
(*Continued on Page* 42)

REEVES
the right speed for every need!

fractional HP Vari-Speed
MOTODRIVE

compact, attractive design

Within streamlined, metallic blue housing is REEVES' "weatherized" motor, time-tested speed changing mechanism, and heat-treated helical gear speed reducer. Maximum space for vertical model only 16 5/16" x 21½" x 11½". Other models equally compact.



simple, accurate operation

14-turn handwheel on Speedial indicator gives you stepless, accurate speeds from 3 to 4660 rpm's—within a 2:1 to 10:1 speed range. Electric remote or automatic controls also available.

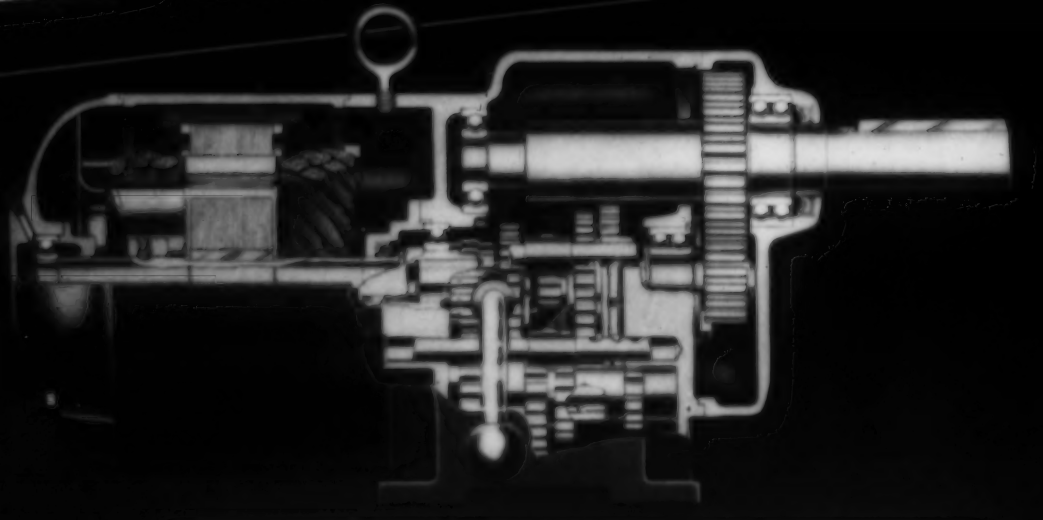
versatile application

Select your *exact* needs from 112 assemblies: ¼, ½ or ¾ hp. units; horizontal left or right, vertical, or 45° left or right models; horizontal or vertical down output shaft.

Write Dept. H19-M543 for complete bulletin.

REEVES PULLEY COMPANY • Columbus, Indiana
Division of RELIANCE Electric and Engineering Co.

NEED SELECTIVE SPEEDS?



— the *RIGHT CHOICE*...

LIMA

Gearshift Drives

Designed for *Continuous* HEAVY-DUTY Service

LIMA GEARSHIFT DRIVES provide an individual power source for machine tools and other equipment wherever constant-horsepower and multiple speeds are required. The modern LIMA *Selective Speed* DRIVE is a compact combination of a four-speed sliding gear transmission and a heavy-duty induction motor. For increased production, lower operating costs, minimum maintenance and maximum safety . . . specify Lima Drives. Experienced Factory Representatives are in the field to give your drive problems immediate and *personal* attention. Write today for the New brochure on Lima Gearshift Drives . . . ½ to 15 Horsepower.

THE LIMA ELECTRIC MOTOR COMPANY, 4890 Findlay Road Lima, Ohio

Representation throughout the U. S., Canada and abroad

FIRST . . . FOR DRIVES . . . MOTORS . . . SPEED REDUCERS

portrait of

A New Approach to Perfection

LIMA

New NEMA Frame Sizes

No longer is it necessary for the designer to compromise motor power or performance to meet size and weight limitations!

Now, Lima has in production all ratings in new NEMA frame sizes 182, 184, 213 and 215—with the 254U through 326 frames following on an accelerated schedule.

If your application requires greater efficiency in a smaller size with less weight, better protection and longer service-free life . . . then these new Lima Motors have been designed for you! Get detailed information from your Lima Representative now. If he is not already calling on you, his name and address will be found in the following Trade Directories: *Thomas' Register, Mac Rae's Blue Book*, or *Conover-Mast Purchasing Directory*.

Of course, the former NEMA frame sizes 66 to 505 (⅓ to 150 H.P.), incorporating the latest advances in motor design, will remain in production.

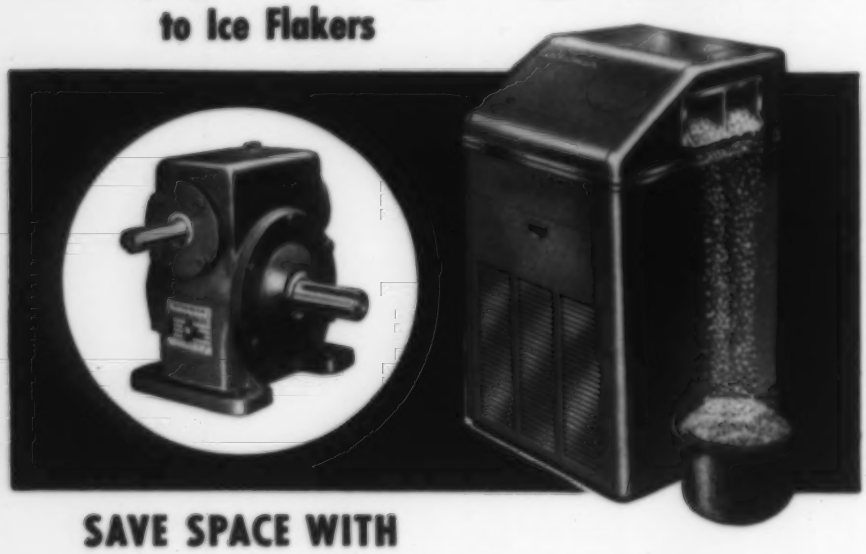
THE LIMA ELECTRIC MOTOR COMPANY, 4879 Findlay Road Lima, Ohio

Representation throughout the U. S., Canada and abroad

FIRST . . . FOR MOTORS . . . DRIVES . . . SPEED REDUCERS

HOT OR COLD

from Drying Ovens to Ice Flakers



SAVE SPACE WITH

WINSMITH

SERIES "C" SPEED REDUCERS!

For *every* speed reducer application where space is at a premium, you'll put a premium on the new Winsmith Series "C" Speed Reducers. With this series, Winsmith achieves stepped-up horsepower and torque output without increase in overall size. Pricewise, this means that the "C" Series Reducer gives you more value than ever offered for your horsepower dollar.

The streamlined Scotsman Ice Flaker, manufactured by the American Gas Machine Company, is an example of how one manufacturer uses Series "C" Reducers to make every inch of space count. Because of *compactness*, the model "CT" reducer has been selected for use on the complete Scotsman Line. And, equally important, — *trouble-free operation* — is another reason the American Gas Machine Company gives for selecting this series!

This view of the mounting arrangement in the Scotsman Ice Flaker, shows the 10" pulley attached to the high speed shaft of the reducer.

Driven by a ¼ hp motor at 1725 rpm, with a reduction ratio of 49 to 1, these "CT" reducers are helping to build a splendid reputation for Scotsman Ice Flakers in thousands of restaurants, hotels, hospitals and institutions throughout the country.

Whatever your products may be — from drying ovens to ice flakers — if you're designing for more streamlined appearance, or, if you're aiming at reducing component size without sacrificing performance, then you should get the complete facts on the Winsmith Series "C" Reducers. Write today for Bulletin HW-654.

WINSMITH, INC.
16 Elton Street
Springville (Erie County), N. Y.

WINSMITH SPEED REDUCERS

...a single source for the most complete line of speed reducers within the range of 1/100 h.p. to 85 h.p. in ratios of 1.1:1 to 50,000:1

News Roundup

(*Continued from Page 39*)

Base-material thickness is between 0.005 and 0.0075-in. Thermal coefficient of Stabilene is 0.000006-inch per inch per degree F in the range 80 to 220 F. This is an average of both directions.

Transparency of the base material is reported to be practically 100 per cent. The pencil and ink surface is about 85 per cent transparent. The scribe coating is actinically opaque but translucent.

Pen and ink surfaces of the film take pencils up to 4H or 5H and most types of drawing inks. The scribe coating is said to permit scribing of sharp lines without chipping at intersections or edges.

Among suggested applications for the film are the manufacture of templates for large blanking and piercing dies, or the checking of templates for complex forgings and structural members in wing and fuselage sections of aircraft. Full-scale drawings used in such applications may be reproduced by contact printing directly on the template or tool material, according to the company. Printed circuits and wiring design are other applications for which Stabilene might be used.

Impact Tube Gives Sudden Shock

Device Tests Materials For Sudden Load Effects

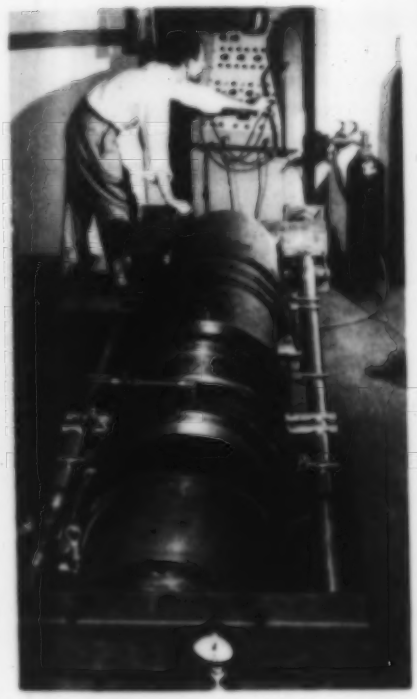
Response of metals and plastics to impact is being tested by a new technique developed in the Research Div. of New York University College of Engineering. Called an "impact tube," the instrument measures the effect of impact in terms of stress-strain relationships.

Essentially, the equipment consists of a 14-ft long tube, 18 inches in diameter. The tube is divided into three chambers, a static chamber, dynamic chamber and firing chamber. The specimen is mounted between the static and dynamic chambers. Both chambers are sealed from one another and from the atmosphere.

A plastic sealing diaphragm serves as the outer end wall of the dynamic chamber. This sealing

diaphragm is supported by a specially designed pneumatic piston.

In testing, both the dynamic and static chambers are pressurized equally. Because of the equalized pressure, the specimen does not deform. To create a sudden shock, the plastic diaphragm is ruptured suddenly. The resulting expansion wave travels from the mouth of the dynamic chamber to the specimen resulting in a sudden drop in pressure at the specimen. Pressure balance is destroyed in about 0.01-second, and the pressure in the static chamber impulsively loads the specimen. The amount of load can be controlled by the pressure, and the rate of loading depends upon the length of the tube.



Impact tube at New York University is used for testing material subjected to sudden loads. Outputs of the sensing elements inside the tube are connected to the oscilloscope

Dynamic chamber pressure is sensed by a pressure transducer mounted at the specimen position. Electrical strain gages detect the specimen response. Outputs of all the sensing elements are applied to a multichannel high-speed oscilloscope. According to NYU researchers, a complete experiment can be run in a few minutes.

When it sings out, engineering mysteries unfold

The high-pitched whine of a high speed camera is bursting forth more and more often in modern engineering laboratories. For engineers have found that ultra-slow-motion movies make trouble shooting in fast-moving parts more a matter of intelligent visual analysis than of tedious cut-and-try experimentation or calculation. And that leaves them more time for design and development work.

The high speed camera we make is primarily for the practical engineer to use in helping solve his day-to-day problems. Its top speed is a reasonable 3200 pictures a second. That slows action 200 times when you project the 16mm film at normal speed, enough in the great majority of mechanical problems to see what's going on. You don't burn up more film than you need and the instrument is simple and rugged enough for a busy man to use without trouble.

The best way for you to evaluate the Kodak High Speed Camera in terms of your own needs is to send for a booklet that not only gives you the details but quite a few case histories on how it has been used in a variety of industries. You get the booklet by writing to *Graphic Reproduction Division,*

EASTMAN KODAK COMPANY
Rochester 4, N. Y.

the Kodak HIGH SPEED Camera

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Highest salary offer compatible with your job qualifications.

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News Roundup

At present, studies are being conducted on the response of various aluminum, steel and titanium alloys to impulse loads of various magnitudes. Data is being obtained in both the plastic and elastic region. Studies are also being conducted on the failure of materials under impact loads.

Dynamic response of diaphragms of aluminum alloy, annealed low-carbon steel and annealed stainless steel have been obtained for loadings into the yield region of these materials. Low carbon steel, for example, is reported to show irregular behavior in the yield region. Lines of local straining were found to assume different patterns in static and dynamic loading. A circumferential pattern is evident with static loading while the pattern is generally radial with dynamic loading.

Results of these experiments are expected to be useful in design of structures subject to sudden loads. Included in structures of this nature are aircraft equipment and buildings that may be subjected to bomb blast. Metal stamped out by heavy presses may also be the subject of extensive research.

"Scrom may crack with this one. He's trying to design a non-slipping, non-locking fastener."

Barry Corp. of Watertown, Mass. announced that it has changed its name to **Barry Controls Inc.** Barry Controls manufactures engineered mountings to control noise and vibration.

Plastics materials production has at least doubled every five years, according to the U.S. Dept. of Commerce, growing from 5.9 million pounds in 1922 to over 2.9 billion in 1953.

Meetings

AND EXPOSITIONS

Aug. 22-23—

Symposium on Electronics in Automatic Production to be held at the Sheraton-Palace Hotel, San Francisco, Calif. Sponsored by the Stanford Research Institute and the National Industrial Conference Board. Additional information may be obtained from the Public Relations Dept., Stanford Research Institute, Stanford, Calif.

Aug. 24-26—

Western Electronic Show and Convention to be held at the Civic Auditorium, San Francisco, Calif. Additional information may be obtained from Mal Mobley, Jr., Business Manager, 344 North La Brea Ave., Los Angeles 36, Calif.

Sept. 6-17—

National Machine Tool Builders' Association Show to be held at the International Amphitheatre, Chicago, Ill. Additional information may be obtained from Clapp & Poliak Inc., 321 Madison Ave., New York 17, N. Y.

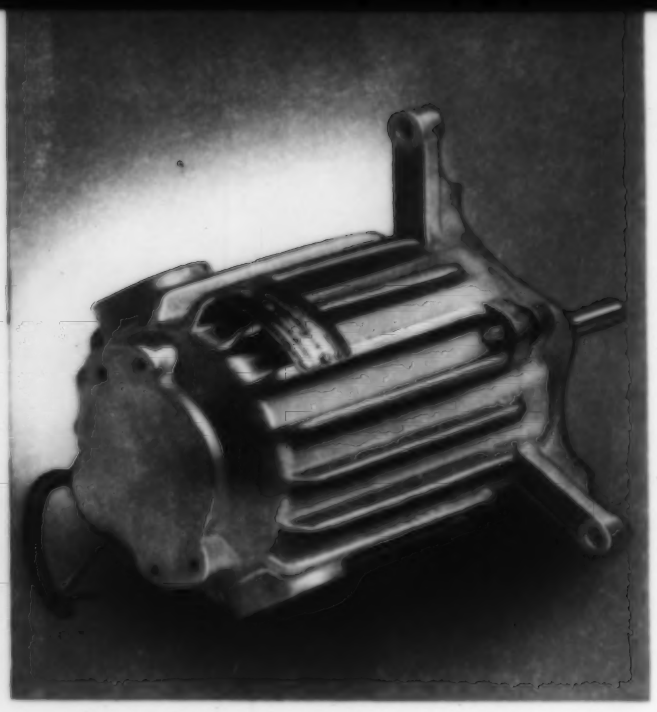
Sept. 6-17—

Production Engineering Show to be held at Navy Pier, Chicago, Ill. Additional information may be obtained from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

Sept. 6-17—

Metalworking Machinery & Equipment Exposition to be held at the Chicago Coliseum, Chicago, Ill. Managing director is William H. Eisenman, 2689 East Overlook Road, Cleveland 6, O.

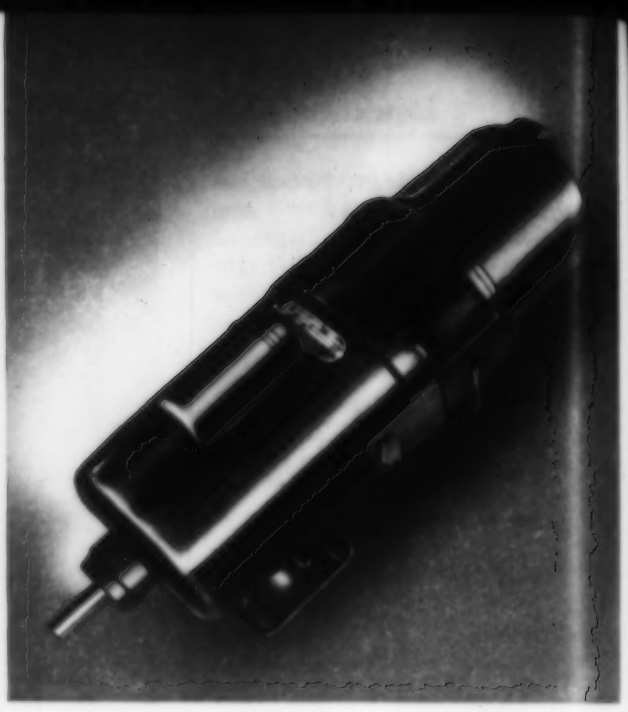
(*Continued on Page* 48)



1. UNIVERSAL MOTOR FOR BLOWER MEETS LIMITED SPACE REQUIREMENTS

General Electric engineers were asked to supply a specially mounted motor for an axial fan. Among the special considerations were a limited amount of space for the motor and need for exceptionally long brush life.

The space problem was solved by G-E engineers with a universal motor designed with a special tripod mounting, extended bearing nose, and a diameter of only $6\frac{5}{16}$ inches. Extensive testing proved this motor to have more than required brush life. This General Electric air-over motor can also be supplied in Class 1, Group D, explosion-proof construction.



2. SPECIAL DC BRAKE MOTOR DESIGNED FOR LOCOMOTIVE DOOR OPENER

Limited space requirements presented a problem to G-E engineers when they were asked to design and build a motor to open and close a 1200-pound locomotive car door. Another specification: positive starting and stopping action.

A team of General Electric motor experts designed a special space-conserving, side-wall mounted motor to be used with a gear reducer and magnetic brake.

G.E. offers a complete line of d-c motors in the following enclosures: drip-proof, totally enclosed non-ventilated, explosion-proof, severe-duty, navy- and marine-type construction.

These four cases show how you

THIS TEAM OF G-E MOTOR EXPERTS is ready to tackle your special drive problems: (1) Lubrication specialist (2) Mechanical design engineer (3) Vibration specialist (4) Electrical engineer (5) Product design engineer (6) Heat transfer specialist.
1
2
3
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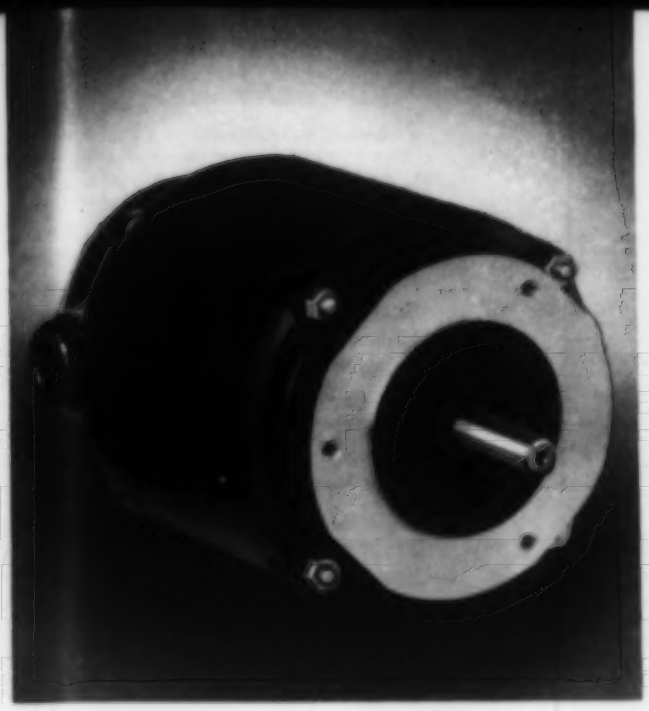


3. SYNCHRONOUS INDUCTOR MOTOR IDEAL FOR LOW-SPEED CAMERA DRIVE

This General Electric customer required a special low-speed motor for an automatic camera drive. Among the customer's specifications was precise starting and stopping action.

Experience indicated that a synchronous inductor motor would be ideal for this low-speed application. The synchronous inductor motor G-E engineers came up with had a rabbet fit for direct mounting to the camera. The motor operates at 75 rpm and a torque of 75 oz-in., and is giving excellent service.

Synchronous inductor motors—a G-E exclusive—are available in 115- and 230-volt ratings 60, 50, and 25 cycles.

4. SHADED-POLE INDUCTION MOTOR TAILORED TO VIBRATING SANDER

An industrial sander manufacturer requested a built-in motor to withstand severe vibrations.

G-E engineers, working closely with customer engineers, helped to develop a hand sander, cool to the touch, by adapting a specially designed shaded-pole motor rotor and stator.

Not only were these shaded-pole motor parts designed to withstand vibrations encountered in application, they also allowed the customer to greatly simplify assembly operations.

G-E shaded-pole motor parts are available in ratings from 15 mhp to 1/12 hp, 115 and 230 volts, 60 and 50 cycle.

solve drive problems when you buy General Electric specialty motors

You buy solutions to your electric drive problems when you buy versatile General Electric specialty motors. These motors, applied by experienced G-E application engineers, can really solve the "tough ones" for you—design problems like those posed above.

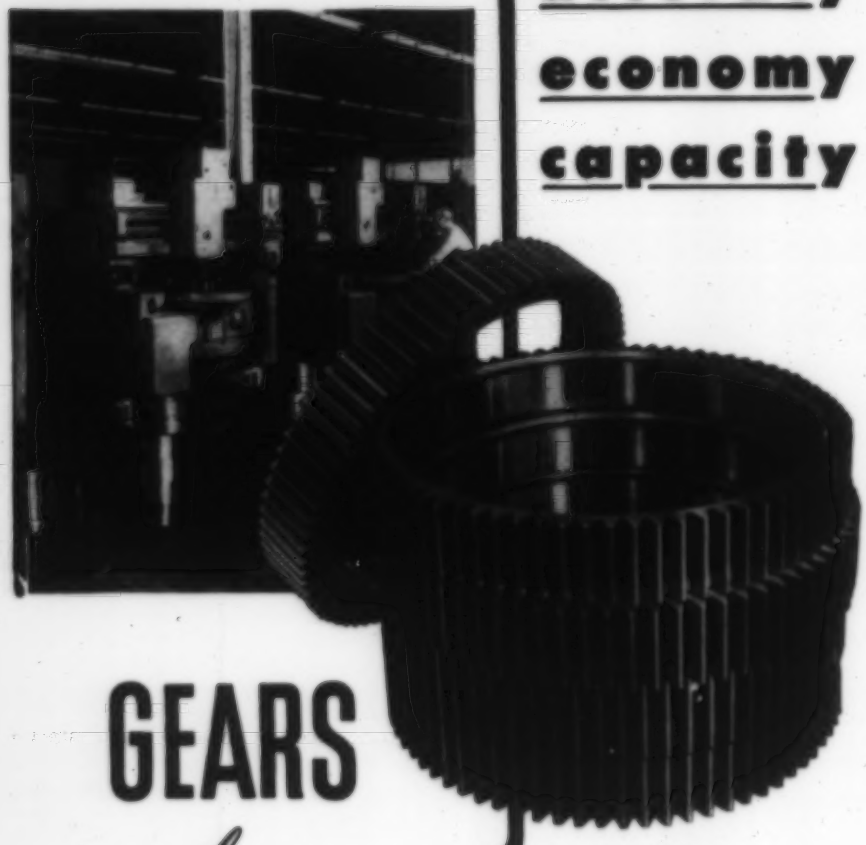
Among the specialty motor products available for your application are: d-c motors and generators, shaded-pole motors, specialty induction motors, amplidynes, tachometer generators, low-speed synchronous inductor motors, dynamotors, and universal motors and parts.

TURN OVER YOUR SPECIAL MOTOR PROBLEMS to General Electric early in your planning by contacting your local G-E Apparatus Sales Office. Or, if you prefer write describing your requirements including quantity and application to Section 704-54, General Electric Company, Schenectady 5, N. Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC

● This picture shows a part of Fairfield's Spur Gear Cutting Department where finest, new equipment is used to produce gears up to 1½ pitch, 36" dia.



accuracy
economy
capacity

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Fairfield

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AT FAIRFIELD, you get the benefit of mass production ECONOMY, combined with every modern facility for manufacturing FINE GEARS!

Here "under one roof" is everything needed to meet your most exacting gear requirements — metallurgical department, batteries of the most modern machines, testing laboratories, complete heat-treating facilities — all operated by skilled craftsmen working under expert engineering supervision.

Get acquainted with the Manufacturing Service Fairfield offers to makers of agricultural implements, road building machinery, machine tools, engines, trucks, tractors, and all kinds of powered equipment. *Your inquiry will receive prompt attention — ask for interesting, illustrated bulletin.*

SPUR GEARS — Straight, helical, and internal. Sizes from 16 pitch, 1½" dia., to 1½ pitch, 36" dia.

HERRINGBONE—(*Follows Type*). Sizes from 1½" to 15".

SPIRAL BEVEL — Sizes from 16 pitch, 1½" dia., to 1½ pitch, 28" dia.

STRAIGHT BEVEL—Sizes from 16 pitch, 1½" dia., to 1½ pitch, 28" dia.

HYPOID—Sizes from 1½" to 28" dia.

ZEROL — Sizes from 16 pitch, 1½" dia., to 1½ pitch, 21" dia.

WORMS AND WORM GEARS—Worms to 7" dia. Worm gears to 36" dia.

SPLINED SHAFTS — Lengths to 52". Diameters from 1" to 6".

DIFFERENTIALS — 10,000 to 300,000 inch pounds capacity.

Note: All of the sizes above are approximate.

FAIRFIELD
MANUFACTURING CO.
2307 South Concord Road • Lafayette, Indiana

News Roundup

(*Continued from Page 45*)

Sept. 12-14—

American Institute of Electrical Engineers. Petroleum Technical Conference to be held at Shamrock Hotel, Houston, Texas. Additional information may be obtained from society headquarters, 33 West 39th St., New York 18, N. Y.

Sept. 12-15 —

Society of Automotive Engineers. Tractor Meeting and Production Forum to be held at Hotel Schroeder, Milwaukee, Wis. Additional information may be obtained from society headquarters, 29 West 39th St., New York 18, N. Y.

Sept. 12-16—

Illuminating Engineering Society. National Technical Conference to be held at Hotel Statler, Cleveland, O. Additional information may be obtained from Charles Amick, Conference General Chairman, General Electric Co., Nela Park, Cleveland, O.

Sept. 12-16—

Instrument Society of America. Tenth Annual Instrument-Automation Conference and Exhibit to be held at Shrine Exposition Hall and Auditorium, Los Angeles, Calif. Additional information may be obtained from society headquarters, 1319 Allegheny Ave., Pittsburgh 33, Pa.

Sept. 15-18

Packaging Machinery Manufacturers Institute. Annual Meeting to be held at The Homestead, Hot Springs, Va. Additional information may be obtained from society headquarters, 342 Madison Ave., New York 17, N. Y.

Sept. 26-29—

Association of Iron and Steel Engineers. Annual convention to be held at the Sherman Hotel, Chicago, Ill. Additional information may be obtained from society headquarters, 1010 Empire Bldg., Pittsburgh 22, Pa.

Sept. 28-29—

Industrial Electronics Conference

to be held at Rackham Memorial Auditorium, Detroit, Mich. Sponsored by the American Institute of Electrical Engineers and the Institute of Radio Engineers. Additional information may be obtained from the American Institute of Electrical Engineers, 33 West 39th St., New York 18, N. Y.

Sept. 29-Oct. 1—

Standards Engineers Society. Annual Meeting to be held at Hotel Statler, Hartford, Conn. Additional information may be obtained from Arnold B. White, Program Chairman, c/o Veeder-Root Inc., Hartford, Conn.

Oct. 3-5—

National Electronics Conference to be held at Hotel Sherman, Chicago, Ill. Sponsored by the American Institute of Electrical Engineers, Illinois Institute of Technology, Institute of Radio Engineers, Northwestern University and the University of Illinois. Additional information may be obtained from J. Kocik, Publicity Committee Chairman, c/o Illinois Bell Telephone Co., 208 W. Washington St., Room 300, Chicago 6, Ill.

Oct. 3-7—

American Institute of Electrical Engineers. Fall General Meeting to be held at the Morrison Hotel, Chicago, Ill. Additional information may be obtained from society headquarters, 33 West 39th St., New York 18, N. Y.

Oct. 5-9—

World Plastics Fair and Trade Exposition to be held at National Guard Armory, Los Angeles, Calif. Additional information may be obtained from Philip M. Kent, Managing Director, 700 Exposition Blvd., Los Angeles 7, Calif.

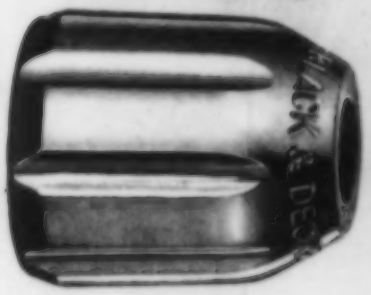
Oct. 6-8—

Society of Industrial Designers. Eleventh Annual Meeting and Design Conference to be held at The Woodner Hotel, Washington, D. C. Additional information may be obtained from society headquarters, 48 East 49th St., New York 17, N. Y.

NOW you can get this brilliant finish directly on zinc die castings!

No electroplating--no mechanical finishing!

PART AS CAST



TREATED WITH NEW IRIDITE

NEW IRIDITE® (Cast-Zinc-Brite)

brightens zinc die castings by chemical polishing, protects against corrosion

NOW, FOR THE FIRST TIME you can get a brilliant, decorative finish directly on zinc die-cast parts . . . without mechanical finishing, without electroplating! The luster is provided by the *chemical polishing* action of new Iridite (Cast-Zinc-Brite) solution. Even surface blemishes, such as cold shuts, are brightened by this new process. No electrolysis. No special equipment. No specially trained personnel. Just a simple chemical dip for a few seconds and the job is done. And, this new Iridite has been *tested and proved* in production.

CORROSION RESISTANCE, TOO! New Iridite (Cast-Zinc-Brite) provides exceptional corrosion resistance for bright-type chromate finishes . . . also guards against blueing or darkening by eliminating zinc plate formerly required in bright chromate finishing of zinc die castings.

AS A BASE FOR ELECTROPLATING—Lower mechanical finishing costs are possible where plated finishes are *required* since the brightness provided by this new Iridite may be sufficient.

LET US SHOW YOU what Iridite (Cast-Zinc-Brite) can do for you. Send us at least a half-dozen typical zinc die-cast parts for FREE PROCESSING for your own tests and evaluation. Or, for immediate information, call in your Iridite Field Engineer. He's listed under "Plating Supplies" in your classified 'phone book. *IMPORTANT: when you give us samples for test processing, please be sure to identify the alloy used.*

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Like everyone else who lives by "ideas," you, too, may now and then find yourself face-to-face with a blank drawing pad, wondering where your *next* idea is coming from . . .

Next time you are, think of a ball . . .

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You're likely to find *so many new ideas* hidden inside *just one* microscopic-size Universal Ball (to say nothing of the bigger ones) you'll have an idea backlog that will *never* run dry.

Fifteen years ago, for instance, who ever thought we'd be using a *ball* as a writing instrument? Well any day, now (perhaps *every* day), someone may design a product that's just as revolutionary . . . A product just as profitable . . . A product built around a Universal Ball—a ball that is *better than* 10-millionths of an inch accurate!

It *could* be *you*. And we'll be glad to help at the drop of a postcard.

Universal Ball Co.

WILLOW GROVE
MONTGOMERY CO., PA.

Engineering News Roundup

Oct. 10-12—

American Society of Lubrication Engineers. Second Joint Lubrication Conference sponsored by ASLE-ASME to be held at the Antlers Hotel, Indianapolis, Ind. Additional information may be obtained from society headquarters, 84 E. Randolph St., Chicago 1, Ill.

Oct. 11-15—

Society of Automotive Engineers. Aeronautic Meeting, Aircraft Production Forum and Aircraft Engineering Display to be held at Hotel Statler, Los Angeles, Calif. Additional information may be obtained from society headquarters, 29 West 39th St., New York 18, N. Y.

Oct. 14-15—

National Society of Professional Engineers. Fall Meeting to be held at the Peabody Hotel, Memphis, Tenn. Additional information may be obtained from society headquarters, 1121 15th St. N. W., Washington 5, D. C.

Oct. 17-21—

National Metal Congress and Exposition to be held at Commercial Museum and Convention Halls, Philadelphia, Pa. Sponsored by the American Society for Metals. Additional information may be obtained from society headquarters, 7301 Euclid Ave., Cleveland 3, O.

Oct. 23-26—

American Gear Manufacturers Association. Semiannual meeting to be held at the Edgewater Beach Hotel, Chicago, Ill. Additional information may be obtained from society headquarters, One Thomas Circle, Washington 5, D. C.

Oct. 24-25—

Steel Founders' Society of America. Fall meeting to be held at The Greenbrier, White Sulphur Springs, W. Va. Secretary is George K. Dreher, 920 Midland Bldg., Cleveland 15, O.

Oct. 24-26—

American Standards Association. Thirty-seventh Annual Meeting in conjunction with the Sixth National Conference on Standards to be held at the Sheraton-Park Hotel, Washington, D. C. Sponsored by ASA and the National Bureau of Standards. Additional information may be obtained from society headquarters, 70 East 45th St., New York 17, N. Y.

Oct. 25-27—

American Institute of Electrical Engineers. Aircraft Electrical Equipment Conference to be held at the Hollywood Roosevelt Hotel, Los Angeles, Calif. Additional information may be obtained from society headquarters, 33 West 39th St., New York 18, N. Y.

Oct. 27-28—

National Conference on Industrial Hydraulics. Eleventh annual meeting to be held at the LaSalle Hotel, Chicago, Ill. Sponsored by the Illinois Institute of Technology and Armour Research Foundation in co-operation with engineering societies and industrial organizations. Additional information may be obtained from C. A. Arents, Secretary, Illinois Institute of Technology, Technology Center, Chicago 16, Ill.

Oct. 31-Nov. 1—

Magnesium Association. Annual meeting to be held at the Biltmore Hotel, New York, N. Y. Additional information may be obtained from society headquarters, 122 East 42nd St., New York 17, N. Y.

Oct. 31-Nov. 2—

Society of Automotive Engineers. Transportation Meeting to be held at The Chase Hotel, St. Louis, Mo. Additional information may be obtained from society headquarters, 29 West 39th St., New York 18, N. Y.

May 24-25, 1956—

Third Conference on Mechanisms to be held at Purdue University, West Lafayette, Ind., sponsored by the Purdue School of Mechanical Engineering and MACHINE DESIGN. Additional information may be obtained from the Editor, MACHINE DESIGN, Penton Bldg., Cleveland 13, O.

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STEELFLEX
COUPLING

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- Any Service
- Any Application, Horizontal or Vertical
- Always available

The exclusive grid-groove design of FALK Steelflex Couplings

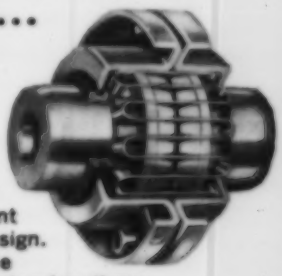
protects your machinery in two ways

You get double protection when you connect your driving and driven machinery with a Falk Steelflex Coupling—the all-steel-built coupling with the exclusive grid-groove design! First, its torsional resilience smothers shock and vibration; and second, the Steelflex design prevents damage and lowered efficiency by accommodating shaft misalignment.

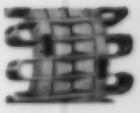
Why have increasing numbers of key men in industry standardized on Falk Steelflex Couplings? Their experience has proved that Falk Steelflex Couplings prolong the service life of their machinery...are trouble-free and need minimum maintenance...are easy to install, lubricate and disconnect ...and cost less per year of service than ordinary couplings.

One basic Steelflex design—the Type F, in its many sizes—is adaptable to more than 90% of all industrial applications. This facilitates buying, as well as prompt replacing and servicing when necessary. Write to Department 247 for engineering bulletin, including selection and dimension details.

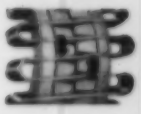
How shock and vibration are smothered by the FALK Steelflex Coupling's Torsional Resilience...



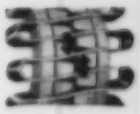
This cutaway view shows the sturdy all-steel construction, also the exclusive, torsionally resilient grid-groove design. Here is how the grid-groove design functions:



UNDER LIGHT LOADS The gridmember bears only at outer edges of grooves. The long span between points of contact remains free to flex under load variations.



UNDER NORMAL LOADS As load increases, the distance between supports on grooves is shortened proportionately, but a free span remains to cushion shock loads.



UNDER SHOCK LOADS Under extreme overloads, the gridmember bears fully on the grooves and transmits full load directly. The coupling remains flexible, within its rated capacity.

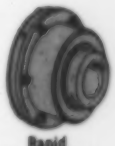
SHAFT MISALIGNMENT ACCOMMODATED
Free End Float Permitted

Controlled flexibility in the FALK Steelflex coupling provides compensation for parallel and angular shaft misalignment—and permits free end float for the shafts of the driving and driven members, or of either one.

PARALLEL MISALIGNMENT

ANGULAR MISALIGNMENT

FREE END FLOAT



Rapid CM—Reversing Service

H and HH High Speeds

FS—Limited Space

BW—Brakewheel Service

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P and PP Extended Shaft

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In addition to the standard Type F (which meets more than 90% of all applications), special or dual purpose Steelflex designs are available for unusual applications. A few of the many types are shown here.

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The Calivolter is a precise electrical instrument which provides an accurate voltage output over a wide frequency range. True r.m.s. voltages regardless of waveform, and accuracy of ±½% are outstanding features. The Calivolter fills a long recognized need for an extremely accurate but inexpensive voltage standard.

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WHAT THE CALIVOLTER DOES

The Calivolter may be used to measure accurately the e.m.f. of voltage-producing vibration, pressure, and seismic pick-ups, as well as strain-measuring devices. It provides a means for accurately calibrating voltage detectors and voltage-sensitive devices such as Vacuum Tube Voltmeters, Oscilloscopes and Sensitive Relays. It may also be used for over-all calibrations of Recording Systems, and for measuring the frequency-response of Amplifiers, Recording Systems, Transformers, High Impedance Meters, etc

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- *Voltage output from 10 microvolts to 10 volts in 5 continuous ranges.*
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- *Current output — 1 microamp to 10 ma in decade steps.*
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- *Small size (8" x 8½" x 4" o.a.)*
- *Lightweight (6¼ lbs.), sturdy construction, matchless quality.*

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MEN

OF MACHINES

At the recent annual meeting of the American Gear Manufacturers Association, **Marvin R. Anderson** was elected president of that organization for 1955-56. Mr. Anderson, whose father was one of the founders of Michigan Tool Co., Detroit, joined that company in 1935. He had received a degree in mechanical engineering from Michigan State University and had

Marvin R. Anderson

earned additional credits in the field of metallurgy. At Michigan Tool, after working in the shop to become familiar with all phases of manufacturing, he served as standards engineer, assistant chief engineer, and vice president. At present he is executive vice president. Mr. Anderson is a member of the Society of Automotive Engineers, the American Society of Tool Engineers, the National Machine Tool Builders' Association and the Metal Cutting Institute.

Other new officers of the AGMA are: vice president, **Fred R. Eberhardt**, president of Eberhardt-Denver Co., Denver; and treasurer, **G. E. Gunderson**, president of Brad Foote Gear Works Inc., Cicero, Ill.

Howard J. Findley has been appointed assistant director of engineering by Eaton Mfg. Co., Cleveland. He joined the company in 1937 as chief engineer and plant manager for the Heater Div. and since 1946 has been manager of research at the Central Research Div. In his new position Mr. Findley will be working on research and engineering activities with all of the company's divisions and subsidiaries.

Announcement was made recently of the appointment of **Rodney D. Chipp** as director of engineering for all manufacturing divisions of Allen B. du Mont Laboratories Inc., Clifton, N. J. Mr. Chipp has directed engineering for the Du Mont television network since 1948.

Ipsen Industries Inc., Rockford, Ill., has appointed **Donald E. Wingate** chief engineer. His new duties will include the co-ordination of engineering and technical development programs now in process.

Emil Gross, chief engineer of the hydraulic department since 1950, has been appointed consulting engineer by Allis-Chalmers Mfg. Co., Milwaukee. He has been associated with the company for more than 45 years in the design and construction of large hydraulic turbines. Succeeding Mr. Gross as chief engineer is **Paul D. Hess,** who joined the company in 1937.

Allis-Chalmers has also announced the appointment of **Frank E. Jaski** as engineer in charge of pump-turbines.

Emory W. Worthington has been appointed vice president in charge of engineering by George F. Motter's Sons, York, Pa. Mr. Worthington has been associated with printing machinery manufacture since 1930.

Harold Nutt recently was elected president and general manager of the Borg & Beck Div. of Borg-Warner Corp., Chicago. He joined the company in 1930 as director of engineering, was elected vice president in charge of engineering in 1946, became vice president and

VIBRATION-DAMPING

SHOCK-ABSORBING

SKID-PROOFING

CUSHIONING

NOISE-KILLING

SCRATCH-PREVENTION

GLAZING STRIP

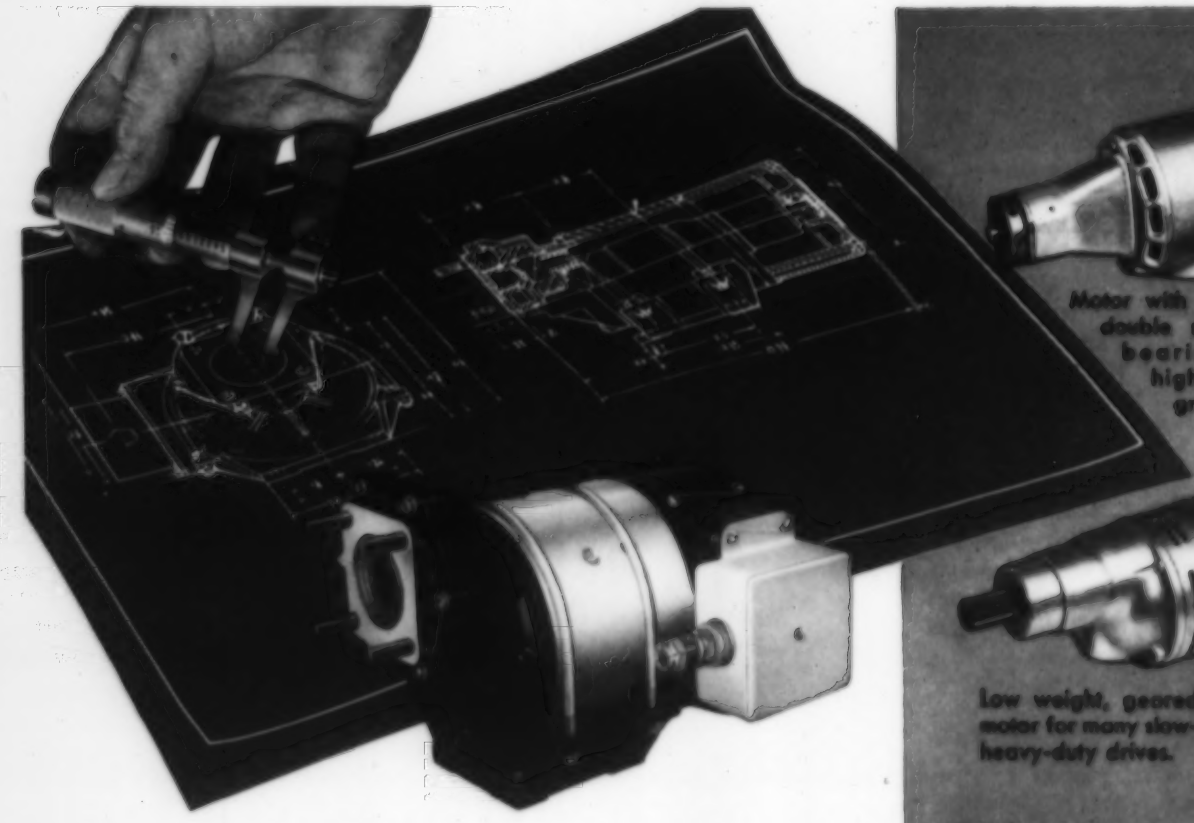
SCRATCH-PREVENTION

Small pads of Armstrong DK-153 Tape keep these G-E stereoscopic viewers—and other portable appliances—from scratching desk and table tops. What's more, this resilient cork-and-sponged-rubber material cushions equipment, reducing clatter when units are put down on metal surfaces.

Pads of DK-153 are available in any size or shape. And they require no special fastening methods or materials . . . pressure-sensitive adhesive sticks to almost any clean, dry surface. Just peel off cloth backing and press pads into place.

Armstrong DK-153 comes in tapes, sheets, and rolls, as well as die-cut shapes, and in thicknesses from 1/32-inch to 3/16-inch. For samples, write on your letterhead to Armstrong Cork Company, Industrial Division, 7308 Dean Street, Lancaster, Pennsylvania. Available for export.

Armstrong DK-153 TAPE



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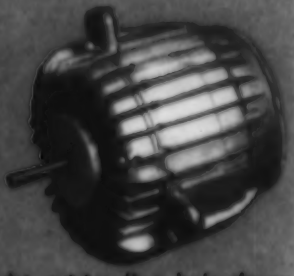

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Motor parts for floor polisher. Adaptable to food mixers and other home appliances.

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Lamb Electric

SPECIAL APPLICATION FRACTIONAL HORSEPOWER **MOTORS**

assistant general manager in 1953 and was made vice president and general manager last year.

Erickson Tool Co., Cleveland, has appointed **Harold Ruehl** assistant chief engineer. Mr. Ruehl was formerly associated with the Industrial Power Div. of International Harvester Co., Melrose Park, Ill., as chief tool engineer.

Arthur Townhill has joined the Harwill Corp., Los Angeles, as director of engineering. Mr. Townhill previously held engineering positions with Aluminum Co. of America, General Motors Corp., Lycoming Mfg. Co., and Thompson Products Inc. During the 20 years of his association with Thompson, Mr. Townhill designed an automatic casting machine and supervised the development of special forging and casting projects.

R. J. Krause has been appointed to the newly created post of chief administrative engineer at the Pacific Div. of Bendix Aviation Corp., North Hollywood, Calif.

Robert J. Lindsey has been named director of engineering by Hydraulic Press Mfg. Co., Mount Gilead, O. Mr. Lindsey attended the college of engineering at the University of Cincinnati and first joined the company in 1940 in the engineering department. He was promoted to assistant chief engineer and later to chief design engineer. He left in 1950 to become chief engineer of the Elmes Engineering Div. of American Steel Foundries and has just returned to HPM to direct the engineering program.

Robert J. Lindsey

William H. Bennett, who has been named vice president in charge of sales, joined HPM as a design engineer in 1939 and was made director of engineering in 1953. He returns to the company from Lake Erie Engineering Corp., where he has been sales manager for approximately six months.

Induction Motors Corp., Westbury, L. I., N. Y., has appointed **Alvin J. Silverman** chief engineer and **Maurice Hayden** project engineer.

Formerly plant engineer, **Paul E. Sanford** has been appointed vice president in charge of engineering by Molded Fiberglass Co., Ashtabula, O.

John R. Moore was recently named director and **Robert M. Ashby,** assistant director of the Electro-Mechanical Engineering Dept. of North American Aviation Inc., Los Angeles.

Vernon R. Degner has joined Barry Controls Inc., Watertown, Mass., as a section engineer. He was formerly a research engineer in the Aerophysics Laboratory of North American Aviation Inc. and previous to that time was employed in the Research Laboratory of Westinghouse Electric Corp.

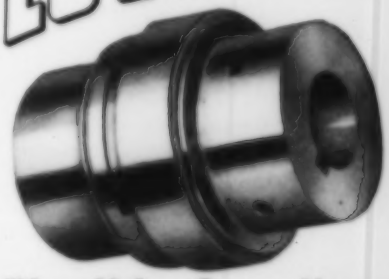
L. W. Buechler has been named chief engineer for Vickers Electric Div. of Vickers Inc., St. Louis.

Mrs. Lois G. McDowell, assistant professor of mechanical engineering at Illinois Institute of Technology, Chicago, has been elected national president of the Society of Women Engineers for 1955-56. Mrs. McDowell was the first woman to receive a master's degree in mechanical engineering at Illinois Institute and one of the first four women engineers accepted

"After 15 Years the Cushions Were Worn"

... actual report on

LOVEJOY



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"Up to fifteen years maintenance-free service is not unusual with Lovejoy lubrication-free flexible couplings."

Performance like this is practical proof of these soundly engineered features:

SIMPLE, RUGGED CONSTRUCTION
Fewer parts. No intricate mechanisms. Nothing to lubricate.

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No wear on the metal jaws.

DOUBLE-LIFE CUSHIONS
One half of the cushions act as idlers—except on reversible loads. A quick interchange provides a new set of cushions. This can be done without dismantling the coupling.

Illustration at right shows a Lovejoy Type CF flange-mounted coupling. Rated at 160 hp., 800 rpm., this space saver connects drive shaft between diesel power unit and generator.

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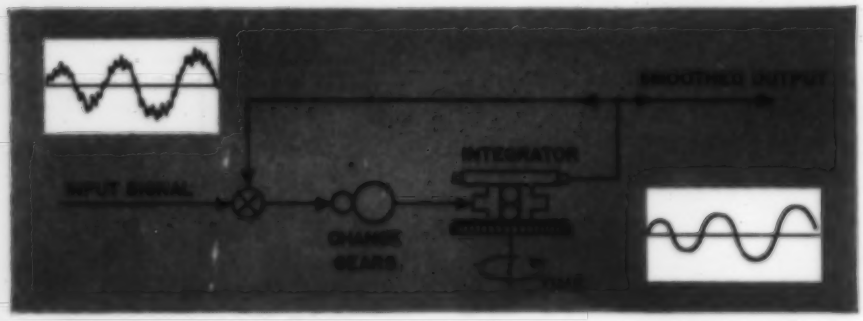
SINCE 1915 LEADERS IN AUTOMATIC CONTROL

Smoothing Signal Noise with the DBR* Integrator

Confronted with the well-known problem of random fluctuations called "noise," Ford engineers have employed the earliest and best-known Ford component – the disk integrator. Used in Ford analogue computers, the disk integrator smoothes random fluctuations due to extraneous influences and obtains an average of the received signal. Thus, a device originally designed by Ford for integration is successfully used as a mechanical counterpart of the RC Filter.



The Ford circuit operates on the premise that the older the data the less important it is. Therefore, data smoothed must be weighted in proportion to its age, so that the weight assigned to it decreases exponentially with time. The output of the circuit then represents the summation of this weighted data and tends to ignore random noises of short time duration.

As shown in the drawing, the incoming signal (with noise superimposed) is the input to the differential. As long as the integrator output (the roller) rotates at the *same rate* as the incoming signal, the differential output (error signal) is stationary and the integrator carriage remains stationary. But any change in the incoming signal produces changes in the *error signal* which tends to displace the integrator carriage and thus restore the system to equilibrium.

This reaction, however, is not instantaneous. It occurs after a certain time-lag which may be adjusted by the gear ratio. If the signal is of brief, random nature, the time-lag of the integrator will prevent its acting on the system. On the other hand, a permanent change in the signal will displace the carriage and change the output of the system.

This use of the Ford disk integrator as a noise smoother exemplifies the flexibility and adaptability of Ford components and ideas.

*Disk, Balls and Roller Integrator

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of unusual abilities can find a future at FORD INSTRUMENT COMPANY. Write for information.

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D. W. Onan & Sons Inc., Minneapolis, has announced the appointment of **James C. Hoiby** as vice president in charge of engineering. Mr. Hoiby, formerly chief engineer, has been associated with the company since 1934. His new duties

James C. Hoiby

will place him in charge of the newly reorganized Engineering Div. and will include both production engineering and development and design. He will also supervise operations in the experimental and drafting departments.

Arthur B. Warner has been promoted to the position of chief engineer by Minnesota Rubber and Gasket Co., Minneapolis.

David S. Muzzey has been appointed associate technical director and is succeeded by **William B. Anspacher** as chief of the engineering department at the U. S. Naval Ordnance Laboratory in Silver Spring, Md. Mr. Anspacher has been deputy chief of the Laboratory. Dr. Muzzey succeeds **Donald E. Marlowe**, who left NOL to become dean of engineering and architecture at Catholic University in Washington.

John J. Dempsey was recently appointed division manager of the

Components Div. of Servomechanisms Inc. at Westbury, N. Y. Mr. Dempsey joined Servomechanisms in 1947 and from 1951 until his recent appointment was chief development engineer for the Eastern Div.

Edward C. Jupa has been promoted from design engineer to senior design engineer at Armour Research Foundation of Illinois Institute of Technology, Chicago. Mr. Jupa, who joined the Foundation as design engineer in 1951, has had a diversified career in mechanical development and design.

Formerly assistant chief engineer in charge of the division's research, development and technical sections, **Ralph L. Bayless** has been named chief engineer of the San Diego, Calif., division of Convair. Mr. Bayless joined Convair in 1936 after serving six years as an aeronautical engineer with the U. S. Air Force. He became chief of aerodynamics in 1944 and was appointed chief development engineer at the San Diego Div. in 1952.

Convair also has appointed **Adolph Burstein** assistant chief engineer and **S. G. Frank Haas Jr.** chief development engineer at the San Diego Div. Mr. Burstein joined the company in 1940 and served with the Stinson and Vultee Field divisions before transferring to San Diego, where he became chief development engineer in 1954. Mr. Haas, who joined the company in 1939 as a structures engineer, later was named assistant project engineer, then project engineer. In 1952 he was appointed chief of preliminary design.

Joseph J. Coleman, chief engineer of Burgess Battery Co., Freeport, Ill., has been made vice president of engineering.

Audio & Video Products Corp., New York, recently announced the election of **James U. Lemke** as vice president and chief engineer for its A-V Mfg. Corp. division. He will supervise all research and development operations.

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MACHINE DESIGN

AUGUST 1955

Engineer or Clerk?

HOW effectively are design engineers employing their time? All too often one hears, "I'm no engineer, I'm a draftsman—or a clerk." A designer is often robbed of creative time by demands upon him to be a communications expert as well. Preparing drawings, memos, change notices, reports, and so on take too much time away from the job that really counts.

Greatest return to the group and to the individual usually results if talents are utilized at the maximum possible level. Organizing to employ engineering assistants or technical clerks is one way of freeing engineers for more effective action.

Work simplification is another promising avenue, whether applied to routine paper work, repetitive calculations, or the preparation of drawings. Time savings with "simplified drafting," for example, are impressive, as shown in the case study starting on the next page.

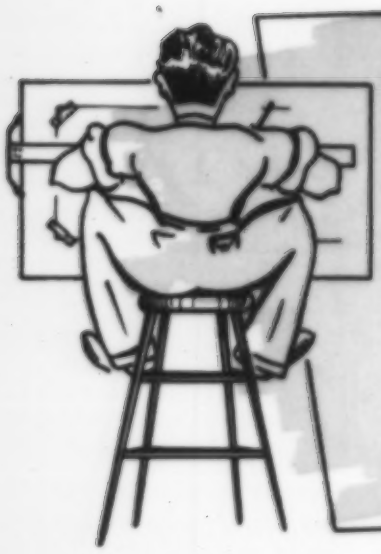
Planning and acting along these lines may well help solve more than one problem.

Designers and engineers will probably continue in short supply for a long time to come. Utilizing existing engineering manpower more effectively could go a long way toward satisfying the demand.

Productivity at a higher level is accompanied by a gain in a man's value to his organization. Many a personal desire for improved economic status might be satisfied if matched by a larger personal contribution to the success of the enterprise.

Ben Hummel

ASSOCIATE EDITOR



A practical approach to Simplified Drafting

By P. Sammarco and A. G. Barows
Advanced Engineering Dept., McCormick Works
International Harvester Co., Chicago, Ill.

THROUGHOUT industry there is much interest in a program of work simplification with engineering drawings—*Simplified Drafting*. The subject has been somewhat controversial and has been misunderstood in many engineering departments where it has been studied.

Simplified drafting can and does reduce the time required to make a drawing. Moreover the simplified type of drawing saves tracing paper and blueprinting costs, without any reduction in drawing scale. Such promise of economy cannot be overlooked.

The McCormick Works Advanced Engineering Dept. of the International Harvester Co., like many others, is interested in better utilization of manpower, and reducing material and duplicating costs. The purpose of this article is to tell how this one design department effectively applied simplified drafting.

The Advanced Engineering Dept. at the McCormick Works of International Harvester is a new product development group whose function is to design, fabricate, assemble, and test new farm implements. The machines are generally composed of castings—simple and complicated; sheet metal—flat and formed; bearings—ball and tapered. In short, almost every conceivable type of machine member can be found in a farm implement, and every one must have a drawing. The drawings are not stereotyped. Simplified drafting does apply to these many types of drawings; therefore, it can quite probably apply to any form of engineering.

Table 1—Drawing Comparison for One Project

	Conventional	Simplified	Reduction*
Views	742	664	78 (10.5 per cent)
Tracings (equiv. to 8½ by 11 in.)	814	601	213 (28.4 per cent)

*Blueprint paper and handling costs were not evaluated although they were significant.

Many claims as to the time saved by simplified drafting have been presented. These saving estimates have ranged from 15 percent to 65 percent. Obviously, the type of engineering work, and the extent to which simplified drafting is practiced, are the factors affecting the time saved.

To gain some idea of how well simplified drafting applied to our drawings, and just how much time would be saved, a tentative list of techniques was first set up to be applied in making drawings by the simplified method. These techniques include group dimensioning, minimized use of compass, minimized use of hidden lines, use of symmetry, and use of written descriptions where applicable.

A group of 300 conventional drawings which were to be released to the shop for fabrication were redrawn using these techniques. A comparison of the two groups of drawings is presented in *Table* 1.

Shop personnel were then given a brief lecture on the aims of the program and shown representative slides of the new and old type drawings. These people were requested to be on the watch for any techniques which might be misunderstood so that the techniques could be reviewed and revised if need be.

Drawings used for this study were 80 percent detail drawings of piece parts and 20 percent assembly drawings (welded and riveted or bolted assemblies). The machine concerned was fabricated and assembled with only minor questions and difficulties arising from the introduction of a new method of drawing.

The techniques were then revised, and an introductory manual printed and distributed. Next, at the request of the chief engineer, all designers and draftsmen applied the tentative rules to all

Can simplified drafting show substantial savings in time and labor—without penalizing clarity of engineering drawings?

The answer is yes, providing . . .

1. Sensible techniques of simplification are developed.

2. Draftsmen are oriented to the techniques.

3. Shop personnel are trained in their interpretation.

4. System is intelligently administered.

This case study shows how one engineering department is taking these steps for more effective utilization of manpower and money.

detail and assembly drawings for a period of three months.

This second trial period of the simplified drafting techniques showed much promise as a time saver, and it was felt that the method should be organized and standardized for the most effective use within the department.

A group of four members of the engineering department were appointed to a Simplified Drafting Committee. Members of this committee were selected on the basis of what they could contribute in the way of experience with shop practices, with simplified drafting, with conventional drafting practices, and most important, the willingness to help simplified drafting become established. The function of the committee was to give orientation

Simplified Drafting
Techniques and Methods

The data sheets which follow comprise most of the "standard" techniques recommended by the Simplified Drafting Committee of the Advanced Engineering Dept. at the McCormick Works. They are presented here to show how details can be reduced and to provide suggestions to others interested in initiating similar methods.

1—General Information

The following techniques and methods are recommended for all drawings and should be used wherever possible:

1.1—Make use of group dimensioning of (a) keyways, (b) length by width by thickness, (c) sections, ribs or holes which are equally spaced and (d) equal radii.

1.2—To locate holes, where possible use notation

ON ℄

1.3—Use symmetry drawing method where applicable. Place following note in conspicuous place so that it will not be overlooked:

SYMMETRICAL ABOUT ℄

Carry part of drawing below center line with broken line.

1.4—Minimize use of hidden lines in secondary views and assembly drawings.

1.5—Minimize number of views.

1.6—Hold paper size to a minimum.

1.7—Use available preprinted sheets where applicable.

1.8—Arrow heads may be eliminated from dimension lines where no confusion results. Stagger dimension lines when a series of consecutive dimensions are shown.

lectures to both shop and office personnel, compile data sheets and expand them as additional usable techniques became evident.

All of the original rules were thoroughly reviewed. Where difficulties with a specific technique were encountered, either in the shop or by draftsmen, they were discussed with the parties concerned. Sometimes, where it was obvious that the same difficulties might arise, the techniques were revised, clarified, or tempered for better understanding.

As a result of the committee's efforts, a final series of data sheets which standardized the simplification techniques to be used by all designers and draftsmen were compiled. Through consistent use, simplified drafting is becoming "second nature" to all concerned.

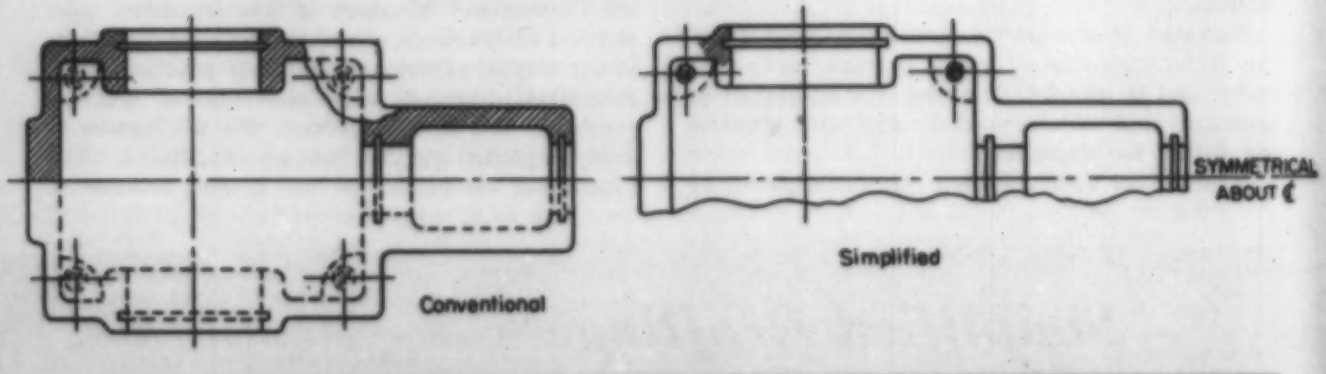
The data sheets (included in this article) contain a brief description of the particular technique plus one or more examples of its application. Copies of the complete series of data sheets were circulated in booklet form to all members of the engineering department, and the Advanced Engineering shop personnel.

Individual indoctrination meetings were held by the committee with the engineering and shop groups. Since questions from each group were of a somewhat different nature, separate meetings proved desirable. A brief orientation of the actual time savings in drawing was given the shop group

2—Crosshatching and hidden lines. Use of symmetry

Minimize, or eliminate entirely where practical, crosshatching on section views. Hidden or invisible lines are to be used only when necessary for clarity. Also use symmetrical drawing method shown wherever possible.

Although two views and dimensions would be required for this example, the illustration shows the elimination of crosshatching and hidden lines.



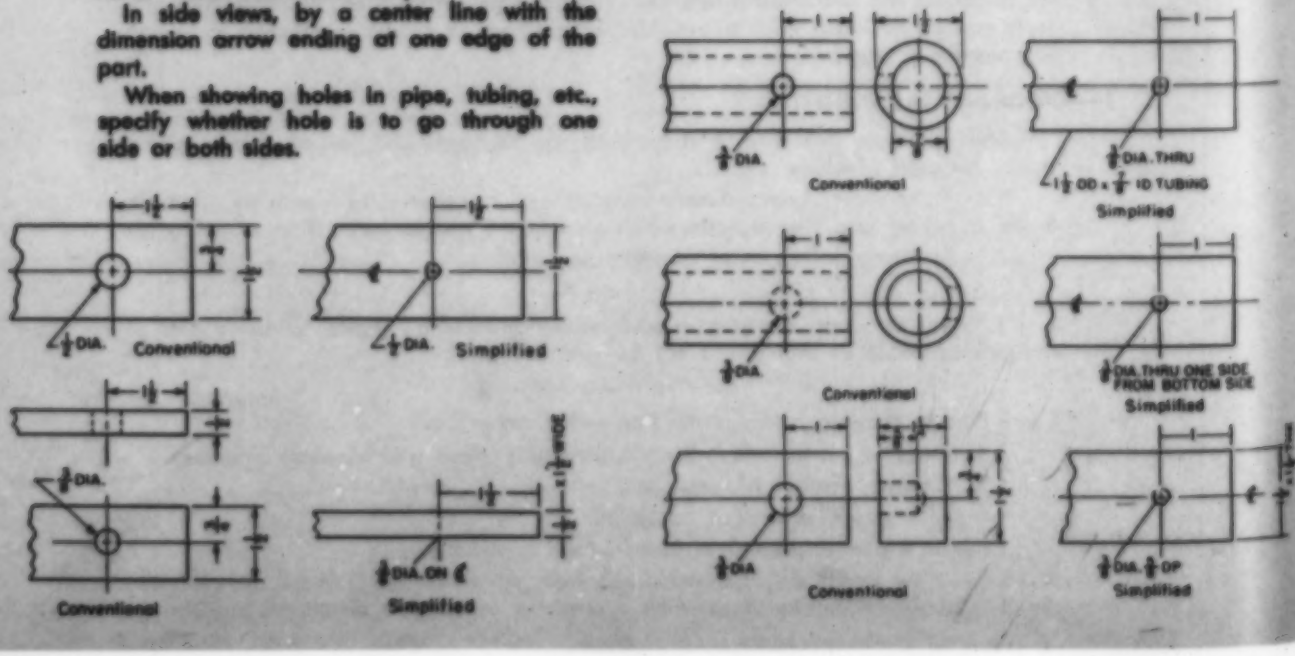
3—Holes

Holes will not be drawn with a compass or template but will be indicated as follows:

In top views, by cross hairs and a small free hand circle at the intersection of cross hairs. Dimension arrow will point to the circle.

In side views, by a center line with the dimension arrow ending at one edge of the part.

When showing holes in pipe, tubing, etc., specify whether hole is to go through one side or both sides.



in order that they might better understand the reason for simplified drafting. Each rule or technique was discussed by a committee member and questions were answered.

By no means is it felt that the standards set up are complete. However, as other techniques are conceived, the data sheets will be expanded.

Although the data sheets contain only one example of an assembly or weldment, the simplified technique is used in all subassembly drawings. Since no hard-and-fast rule can be set up for assemblies, simplification is left to the draftsman's discretion. With common sense, practically every assembly can be simplified.

It is true that the presentation of any new idea meets with a certain amount of opposition. Simplified drafting is no exception, and the initial trial periods had their dark moments. However, through the efforts of the Simplified Drafting Committee in studying, organizing, and revising the program, it has been accepted and successfully put into operation within the department.

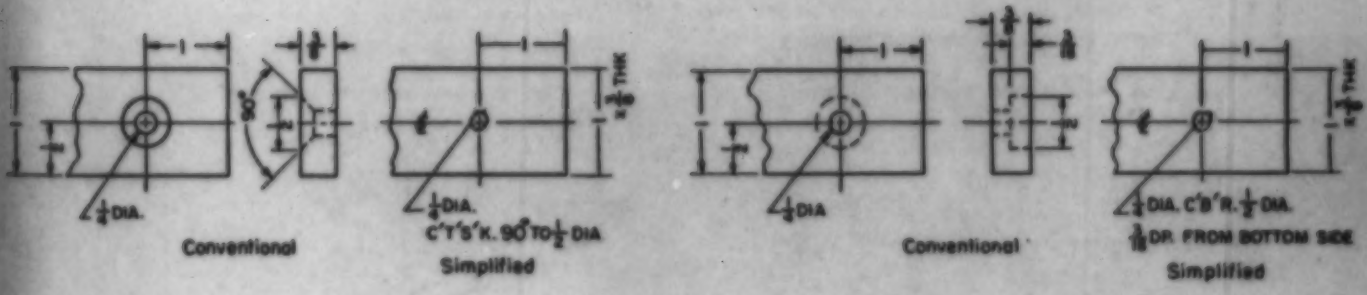
Since drawings were used by three different groups in fabricating parts, some idea can be given of how well the simplified drawings were received by people with different degrees of orientation to the subject. The Advanced Engineering

4—Countersunk, counterbored and spotfaced holes

Countersinks and counterbores will not be drawn. Countersinks will be specified by angle and diameter. Counterbores will be specified by diameter and depth.

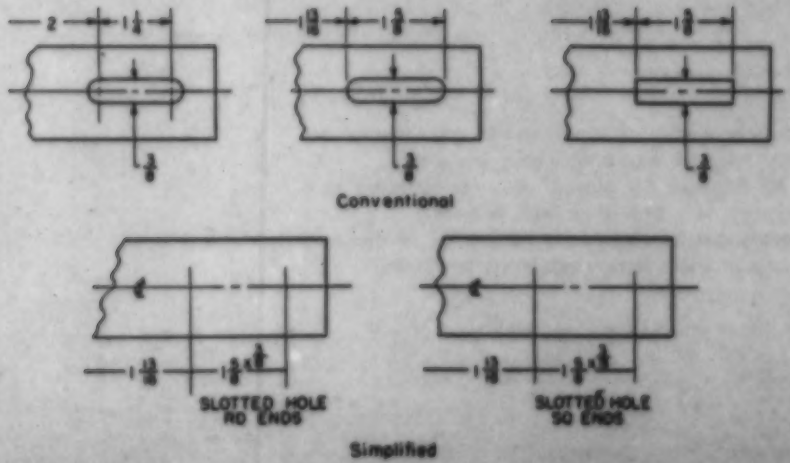
Spotface will be specified by diameter.

Hole will be countersunk, counterbored or spotfaced from the side to which the arrow points unless otherwise noted.



5—Slotted holes

Slotted holes will not be drawn but will be specified by group dimensioning of the overall length by width and will be noted round or square ends.



machine shop, which has been indoctrinated to simplified drafting by meetings and data sheets, had little or no difficulty. Pattern and machine shops within the company, but which are not a part of Advanced Engineering, have not been indoctrinated and are not at present working regularly from simplified drawings. Although an occasional inquiry or phone call about a simplified drafting drawing is received, no serious difficulties due to simplification have arisen. Outside job shops are the third source of supply. Very little, if any, difficulty has been encountered, since these shops work from all types of drawings received from many companies, some of which are also using simplified drafting.

Consequently, it is felt that the time saved by using simplified drafting more than offsets the small amount of time spent on inquiries from those people thoroughly unfamiliar with the method. Experience has already shown that the questions and inquiries soon diminish as shop men realize that they are working from a simplified drawing which contains all the information they require.

After an experimental machine has been completed in the Advanced Engineering Dept., all drawings are turned over to a product engineering group in their existing simplified form. Since the simplified drafting technique is still comparatively new in the company, it is not yet known how the drawings will be handled by other groups.

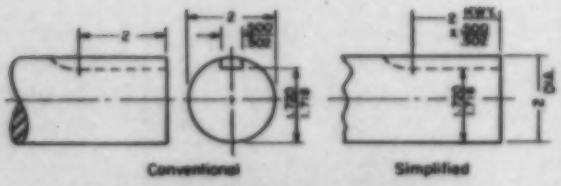
The introduction of a new drafting method other than that prescribed in the company standards naturally required a factual basis of its potential value, when presented to engineering management. Conducted by the chief engineer of the department, a statistical study showed that the simpli-

6—Keyways

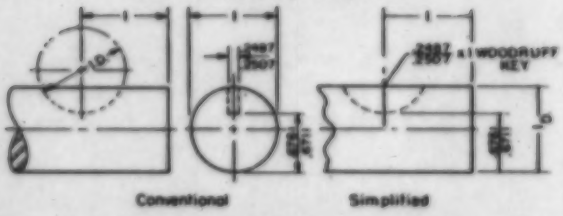
Keyways lend themselves to group dimensioning. With keyways in shafts the dimensions should appear in the plan view, thus eliminating the need for an end view in almost all cases. The same follows for keyways in hubs of gears, sprockets, etc.

For tapered keyways, the maximum depth of dimension is given and the amount of taper, ⅛ or 5/16-inch per foot. Woodruff keyseats are handled in much the same manner as straight keyways.

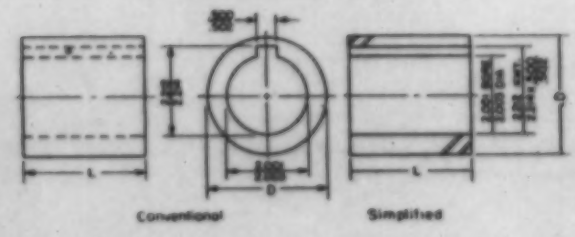
6.1—Straight keyway in shaft



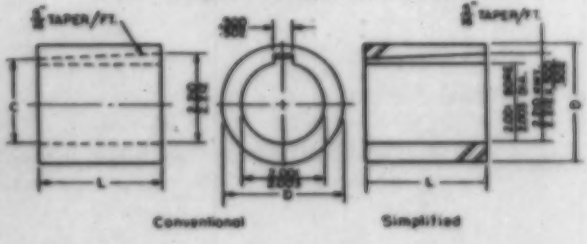
6.2—Woodruff keyseat



6.3—Straight keyway in hub



6.4—Tapered keyway in hub

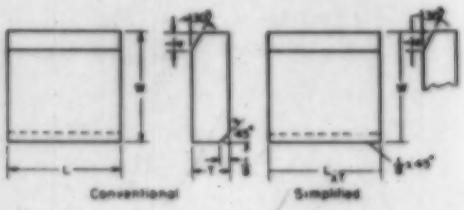


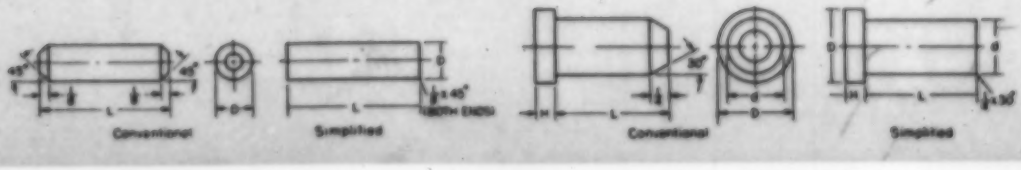
7—Chamfers

Drawing chamfers on shafts, pins, bolts, etc., is unnecessary since they may be explained fully by note.

Bevels at 45 degrees on plates, etc., for welding purposes may require only one view with a note.

Bevels at other angles should be called for in the conventional manner if there is any doubt as to clarity.





fied procedure saves 43 percent of the time required for conventional "detail" drafting.

Time saved by the simplified method of drafting helps alleviate the shortage of engineering manpower, and represents, in effect, the addition of approximately one full-time engineer to the department at no extra cost.

Management reaction has been quite favorable, and manuals have been circulated to other engineering departments within the division.

Simplified drafting is not at present a Harvester drafting standard. Advanced Engineering is merely the pioneer group that has investigated and presented its merits. The principle is still young and only time will show whether or not it will be accepted on a company-wide basis.

Without question, the idea of simplified drafting is a worthy one. But many in industry resist it perhaps because it appears to be new and unproved. It is not a new concept of engineering drawing. It is merely the emphasizing of time-saving drawing techniques. The techniques only seem new. With the establishment of a practical method, complete with reference or data sheets of proved techniques, simplified drafting can be effectively applied by all engineering departments. Efficient use of manpower and economy of operation are the returns on a small investment of time in developing and promoting simplified drafting.

ACKNOWLEDGMENT

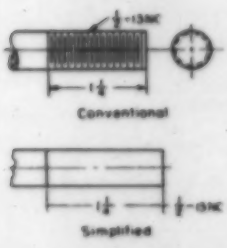
Data sheets included in this article were developed by a committee comprised of P. Sammarco, chairman, S. E. Hilblom, A. G. Barows and R. C. Miner within the McCormick Works Advanced Engineering Dept., E. C. Carlson, Chief Engineer.

8—Threads

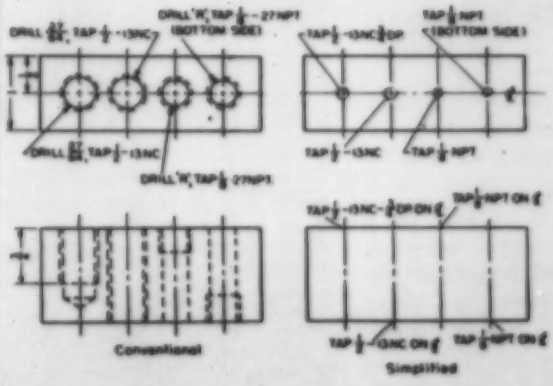
Most of the conventional detail of thread drawing may be eliminated. External threads are shown by the full-depth length required and a note describing the thread. Internal threads are treated the same as holes with appropriate notes.

In side views of tapped blind holes or pipe taps, the note should point to the side where the operation takes place.

8.1—External

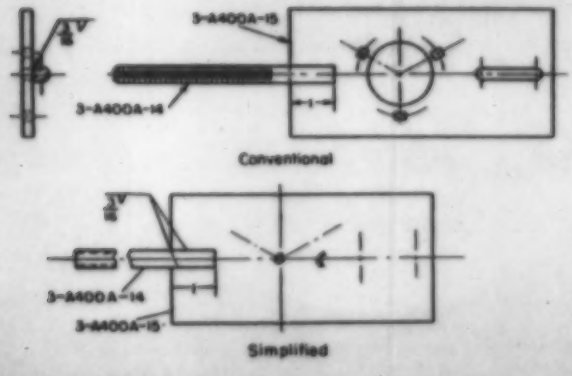


8.2—Internal



9—Weldments

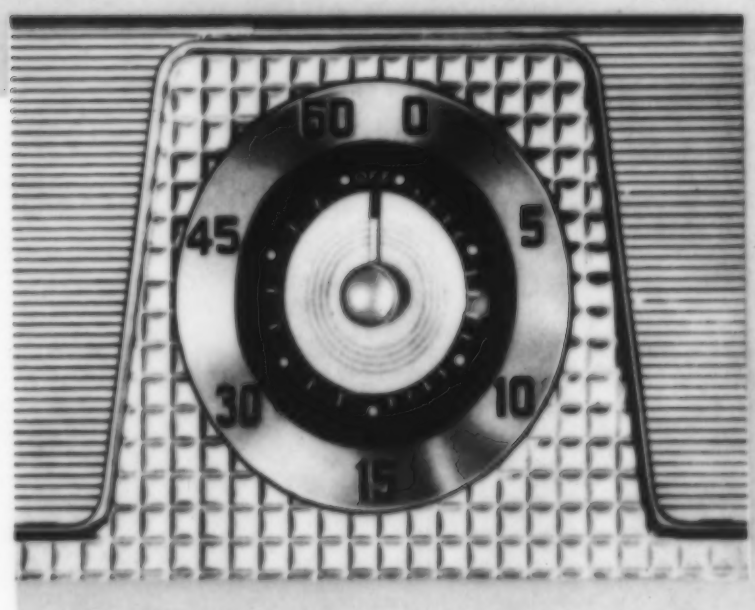
Welding assemblies serve no other purpose than to show what is to be welded, where it is welded and how it is welded. The fewest number of lines that show these three things clearly is the best and simplest drawing.



Comments?

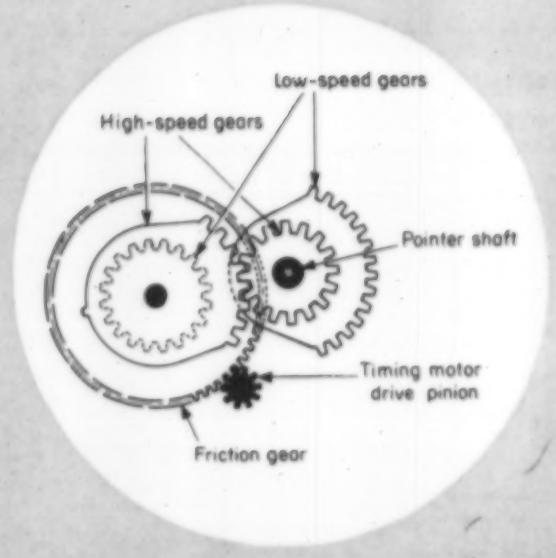
Are you using Simplified Drafting? If you have any ideas on the subject—pro or con—the authors of this article and the editors of *Machine Design* will welcome your comments. Write to Editor, *Machine Design*, Penton Bldg., Cleveland 13, O.

scanning the field for *Ideas*

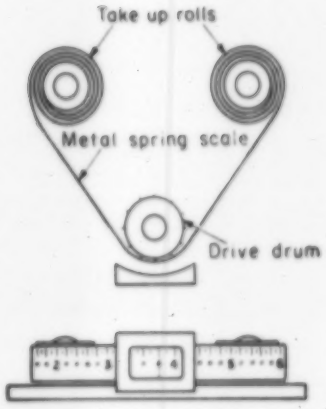


DUAL SPEED RANGE is provided automatically by a novel system of intermediate gearing in an electric timer developed by Lux Clock Mfg. Co. Designed for use on the Kelvinator electric range, the timer employs two sector gears with different drive ratios to control the output speed of a gear train driven by a constant speed motor. A two-speed action is obtained with the timer shifting automatically from low to high-speed operation at a predetermined time setting.

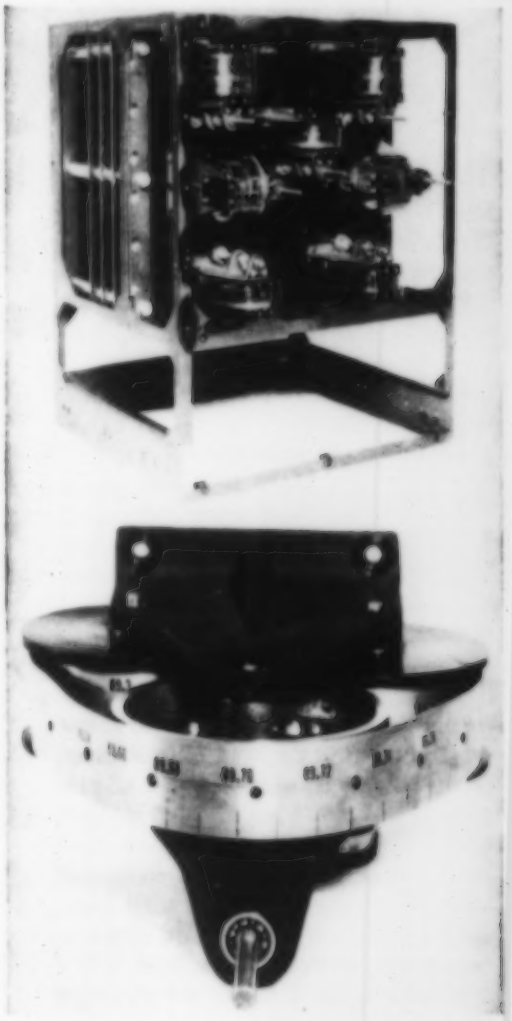
Connection of the sector gears to the gear train and the timer dial pointer is obtained through intermediate gearing. When one of the sector gears is in driving engagement the other gear is out of mesh. The gear train incorporates a "friction" gear which slips on its shaft during manual time setting operations.



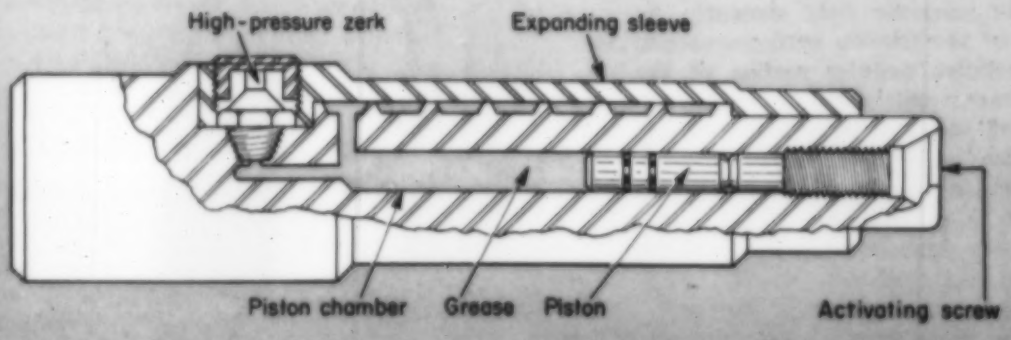
EXPANDED INSTRUMENT SCALES of flat steel strip offer high accuracy and readability even under adverse environmental conditions. In a design developed by Ultrasonic Corp. for use on precision mechanical computers, scales varying in length from 90 to 150 inches have been achieved through the use of Neg'ator springs which are basically flat strips of stainless steel prestressed to form a tight coil when free. Scale graduations are printed by a special process and the steel strips are mounted on small takeup rolls or drums to provide a compact instrument assembly.



Rotation of a drive drum in either direction rolls the metal spring from one takeup roll to the other. Metal pegs in the drive drum meshing in holes along the center of the metal strip prevent slipping. Effects of shock and temperature change are minimized by the all steel construction which is designed so that winding forces are applied at the point where readings are made.



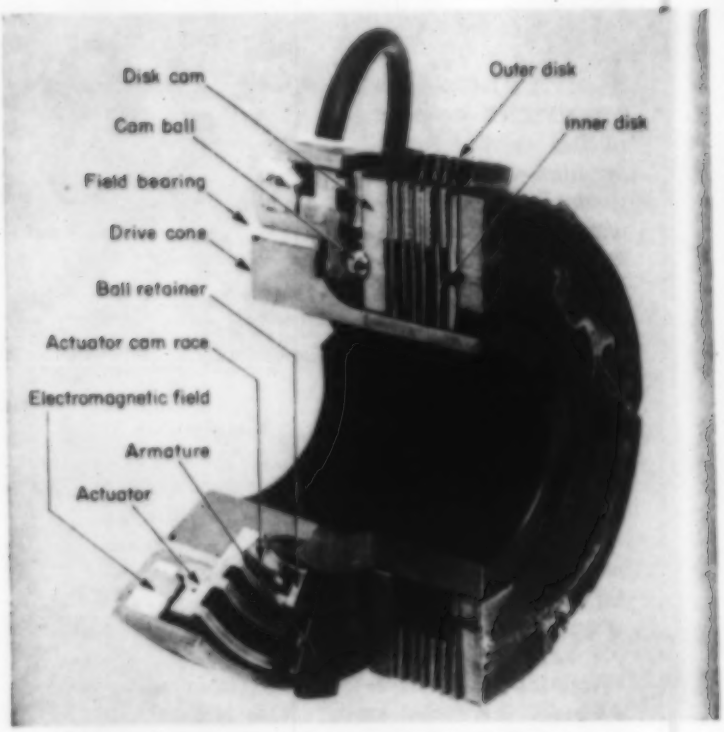
HYDRAULIC LOCKING of rotating shaft members provides a secure drive connection without set screws or keyways. Developed by the A & C Engineering Co., the Hydra-lock arbor uses a steel sleeve, expanded uniformly under hydraulic pressure, to achieve accurate internal chucking of parts. Hydraulic pressure and sleeve expansion are controlled through an activating screw which actuates a piston in a fluid chamber in the arbor body. As the screw is turned, the piston is forced to move in and out in the chamber, increasing or reducing the pressure on the sleeve. Centered alignment of mounted parts is assured by the design which can be readily adapted to either manual or power operation.

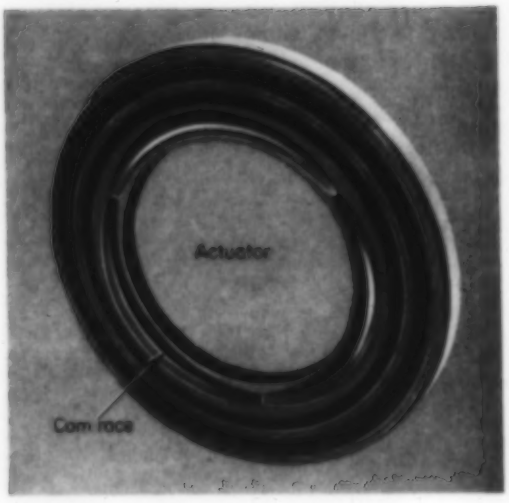


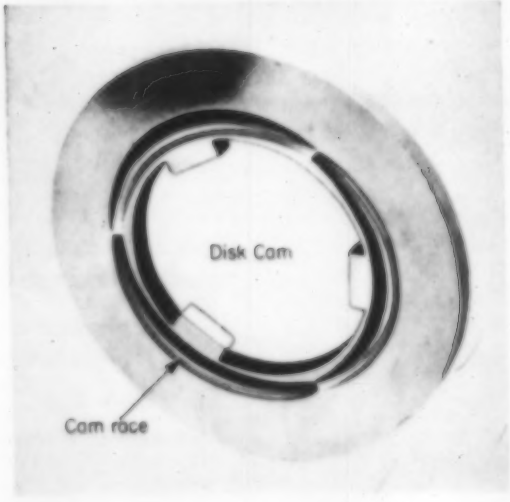
ELECTROMAGNETIC TORQUE CONTROL in a multiple-disk oil clutch design increases load capacity and compensates for effects of wear. Principle of operation of the clutch, which was developed by the Warner Electric Brake and Clutch Co., is a servo action in which an electromagnetic field supplies only a part of the total force required for engagement. The rest of the force is developed through a ball and cam mechanism which is actuated by the input drive shaft. Design of the clutch permits operation in either direction of rotation.

The clutch assembly consists essentially of four main elements: a stationary field coil, a floating actuator unit, and the input and output members. Power transmission is accomplished through a set of friction disks which are mounted to a drive cone and engage mating disks connected to a drive cup through radial lugs. Engagement of the friction disks is controlled by means of a cam action produced by balls which are mounted between the actuator and a disk cam in special mating cam races. Relative angular motion of the actuator and disk cam creates a wedging effect, causing the disk cam to move axially and drive the friction disks into engagement.

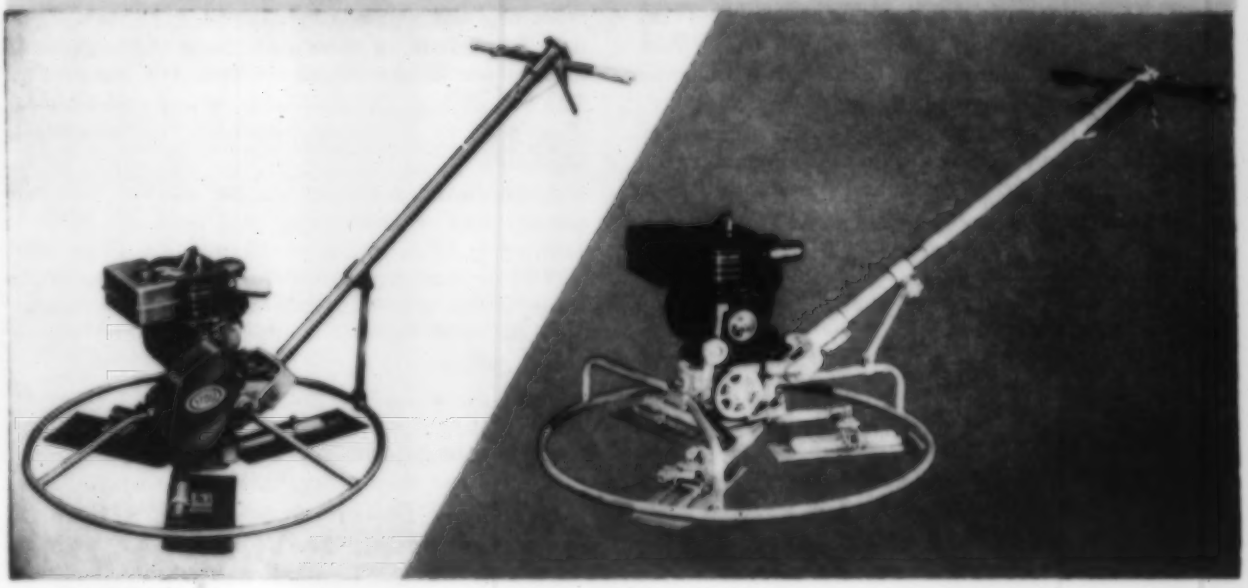
The clutch is engaged by energizing the field coil. Magnetic attraction locks the actuator and an armature ring, causing them to turn as a single unit to produce the required relative angular motion of the cam races. When the field is de-energized, springs return the disk cam and friction disks to the disengaged position. Torque developed by the clutch is a function of the magnetic field strength. As wear of the friction surfaces occurs, the relative angular motion of the cam races and, thus, the axial motion of the disk cam automatically increase to compensate for the reduction in thickness of the clutch plates.







Production version of rotary trowel for finishing concrete, left, as developed for Stow Mfg. Co. by Designers for Industry with prototype model, right.



How a small company successfully developed a new product by . . .

Using an Outside Design Firm

By C. F. Hotchkiss

President
Stow Mfg. Co.
Binghamton, N. Y.

WITH an expected loss of Government contracts at the end of the Korean situation, the Stow Manufacturing Co. of Binghamton, New York decided a new product was needed to increase commercial business. The principal product of the company is flexible shafting, but a line of flexible shaft concrete vibrators is also made, and sold through construction equipment distributors. Serving as a quick "market survey," a letter was sent to all of these distributors with a list of about 20 products that were already on the market that Stow believed they could make. The distributors were asked to list in the order of preference the four products they believed would sell best.

Results indicated strongly that a rotary trowel for finishing concrete, which was made by only a few companies, would be the best item.

Design Procedure: The engineering procedure for the design of this trowel was laid out step by step as follows:

1. Survey, including patent studies
2. Preliminary design
3. Preparation of layout drawings
4. Making up shop drawings
5. Building prototype
6. Testing prototype
7. Making design changes in the prototype
8. Making production drawings
9. Building one machine from production drawings
10. Testing production machine and making necessary design changes
11. Ordering fixtures, jigs and tooling for first production run

Selecting a Design Firm: Now that the product was decided upon and the design procedure laid out, the problem was — who would design the trowel? To a large concern with many engineers this would be no problem, but to a small concern like Stow (116 employees), it was a huge problem. The product is rather complicated and some patented features had to be avoided. Stow wanted some new features which would make this machine excel in operation and yet sell com-

petitively. Also, Stow's distributors wanted the machine in a hurry. If Stow designed the trowel, extra engineers would have to be taken on since the present small engineering staff was kept constantly busy with regular work. On the other hand, an outside design firm could do the job faster, but with a large outlay of cash, and Stow would have less close supervision of the job.

Stow decided to investigate design costs with several outside firms. One concern, Designers for Industry, Cleveland, O., suggested that a "technical survey" be made first. This is done by a separate section of DFI, and Stow would not be required to give DFI the design job after the survey was finished.

Technical Survey: Stow decided to go ahead with the technical survey, which was started November 4, 1953. Besides making a patent study, the technical survey team was to determine:

1. An estimate of sales
2. The over-all picture of competition including the advantages and disadvantages of competitive machines
3. What new features were wanted
4. An acceptable price

The survey was made by interviewing competitors' distributors and contractors who used rotary trowels. They were asked detailed questions about the product and what improvements they thought were necessary. As an independent designing firm, DFI had no trouble getting information from distributors. The information was very useful, not only in confirming Stow's estimate of the potential market but in the actual designing of the product. The survey took 248.3 man hours and cost $2,086.90 plus $365.43 traveling expenses, or a total of $2,452.33.

A preliminary report on the survey was submitted, and a conference was held at Stow on January 6, 1954, to discuss the results. Stow asked DFI to present a proposal for just one size of machine which would include designing and building the prototype, testing it, and making the production drawings.

The figures in the proposal made to Stow are listed in *Table* 1. These are the estimated man-hours required and also the total costs.

Preliminary Design: Stow decided to have Designers for Industry handle the design with the stipulation that DFI submit a preliminary design, which would not infringe any patents, for Stow's review before proceeding with the next steps. This was covered by the first two items in the proposal, *Table* 1, and had an estimated budget of $1840. Thus Stow had a degree of control, since no more than $1840 would be spent before the design would be checked.

Stow prepared a list of features to be considered

Table 1—Man-Hours and Costs Estimated for Developing a New Product

Item	Project Manager	Project Engineer	Project Designer	Designer	Draftsman	Checker	Experimental Manufacturing
Man-Hours							
Patent studies and evaluation	15	30	...	...	...	...	...
Preliminary design	5	50	40	...	80	...	...
Practical experimentation	5	30	30	...	40	...	150
Client conference; modifications	10	10	...	...	...	...	...
Final design	...	40	40	40	...	...	...
Client report; modifications	5	20	...	...	...	...	...
Design execution	...	20	20	20	200	50	...
Prototype-build, test	...	40	...	20	40	...	300
Production engineering	...	50	...	...	...	...	...
Costs:							
Total services (estimated hours)	40	290	130	80	380	50	450
Service rate (dollars per hour)	15.00	10.00	8.50	7.00	5.00	8.50	6.00
Total services (estimated costs)	600	2900	1105	560	1800	425	2700
Total estimated labor	$10,090.00						
Materials and miscellaneous	500.00						
Total estimated budget	$10,590.00						

Table 2—Final Costs for Developing New Product

Item	Project Engineer	Project Designer	Project Manager	Layout Designer	Machinists	Laboratory Assistant	Total
Rate (dollars per hour)	10.00	8.50	15.00	7.00	6.00	5.00	...
Total services (hours)	296.2	17.7	10.00	318.7	445.6	2.1	...
Total costs (dollars)	2962.00	150.45	150.00	2230.90	2673.60	10.50	8177.45

by DFI in the design:

1. *Size*—Should be determined on basis of most popular competitive models.
2. *Engine power*—Must be sufficient to drive machine for floating as well as finishing.
3. *Speed*—Should be adjustable with control at handle to cover range required for floating and finishing.
4. *Power transmission*—Design for long life with oil seals to give trouble-free service.
5. *Trowel-tilting mechanism*—Must be reliable and adjustable at handle while machine is in operation.
6. *Trowels*—Interchangeable, floating or finishing. Should have long life and be easy to change by one man. Must be guarded against striking obstructions.
7. *Clutch*—Use centrifugal type. Consider automatic throttle release to avoid rotation of handle when accidentally released.
8. *Handle*—Must be sturdy for proper control of machine propulsion, adjustable to suit operator's height. Also, consider possibility of folding for space conservation in transport and storage.
9. *General construction*—All vital parts should be adequately guarded or protected against damage from rough handling in transport from job to job.
10. *Engine mounting*—Consider possibility of conversion to electrically driven machine.

Notice that these were constructive comments rather than restrictive specifications. They were based on the technical survey and comments by Stow's distributors. Since Stow had very little experience in the troweling field, the design was left wide open to DFI. By not restricting the design, Stow hoped to get fresh, novel ideas in the design. DFI estimated the prototype could be completed in 90 days.

Six weeks later a conference was held in Cleveland to discuss the preliminary design. Present at this meeting were the president and vice president in charge of engineering at Stow, and the president, product manager and product engineer of DFI.

The preliminary design was novel and interesting. Stow suggested a few design changes which were discussed thoroughly. The changes decided upon were written up in detail. Stow estimated the manufacturing cost, based on material costs and Stow's factory rate for labor.

Authority was given for DFI to prepare assembly and layout drawings based on the preliminary design and the changes discussed. At a second meeting in Cleveland ten days later, DFI was given approval to start with the shop drawings from which the prototype would be built.

Prototype Design: Details on the prototype design were given to the Stow sales department so that they could be discussed with distributors. As a result, several design changes were made.

The prototype was completed and shipped to Stow on April 29. Testing on a slab was begun immediately at Stow's plant and, as a result, some changes were made in the machine, particularly in the method of supporting the blades. Photographs of the prototype were sent to all distributors. Some suggested design changes, such as the lowering of the guard ring so that the machine could go under pipes which are often only 6 inches above the concrete.

At this point, Stow decided to do the production drawings rather than let DFI do them as was originally planned. It was believed that Stow could make the drawings more quickly because of familiarity with factory production facilities. All work was terminated immediately with DFI. The breakdown on the cost of design to Stow, excluding the technical survey, is shown in *Table* 2.

The total of $8,177.45 is less than the estimated total, since Stow decided to make their own production drawings. The total paid to DFI then, including the technical survey, was $10,629.78.

Production: The production drawings were completed by Stow, and one machine was made up from the production drawings. The production model was tested thoroughly. When Stow was perfectly satisfied with the machine, jigs and fixtures were designed and ordered, and a run of 50 machines was started. These were to be put in the field to get the reaction of users before full production was undertaken.

Stow believes that by using an outside design firm they not only obtained an excellent design, but they obtained it quicker than they could have by themselves. Also, they avoided adding temporary engineers to the payroll and interrupting other necessary engineering work.

They Say . . .

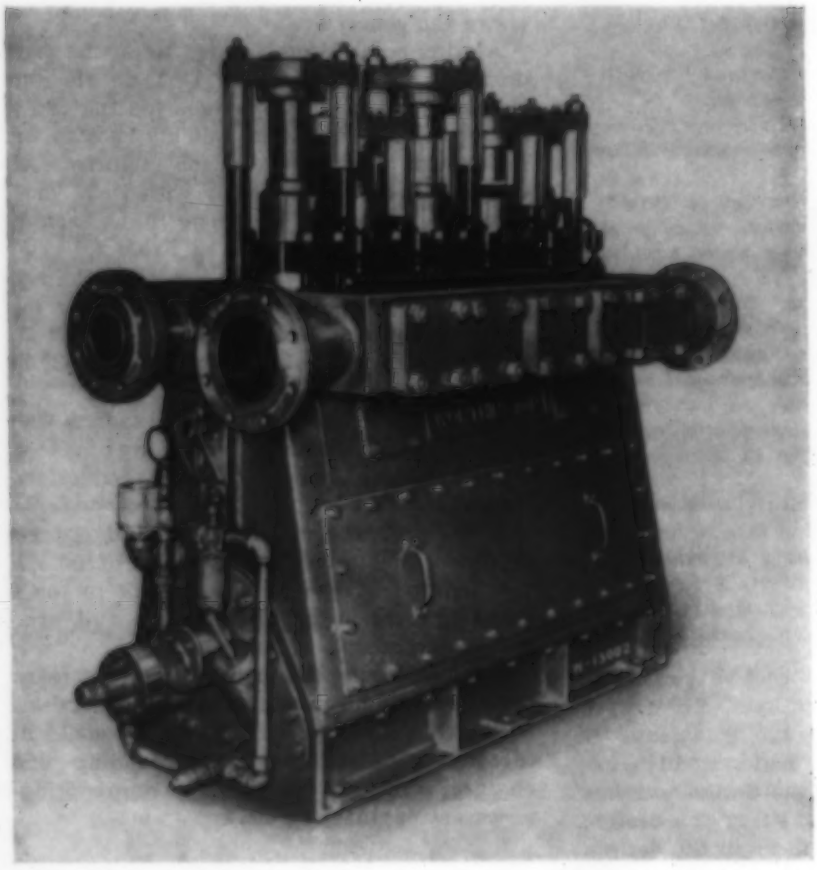
"The technologist, physicist and engineer are moving into a phase where their work will become even more useful and creative.

"It's going to leave us professionally on a much higher plane doing a type of intellectual work which has not yet been appreciated in educational and collegiate circles. It is my firm belief that the automatic and electronic age will introduce creative and imaginative qualities never before within the sphere of organization and institutional activities.

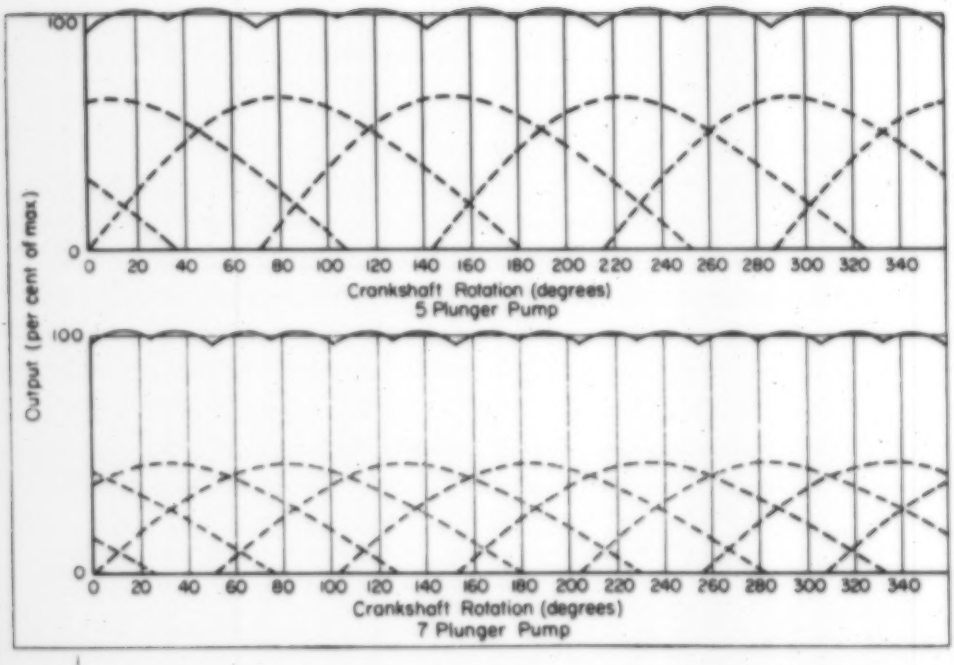
"A better appreciation of training within industry coupled with this new age will make for developments within the next fifty years which should make those of the last fifty seem inconsequential."—DR. ALLAN R. CULLAMORE, *president emeritus, Newark College of Engineering*

"The quest for knowledge is like climbing a pole. The higher you climb, the more distant the horizon, and the greater is the area of knowledge to cover."—GORDON B. CARSON, *director, Engineering Experiment Station, Ohio State University*

Contemporary Design — *Interchangeable*

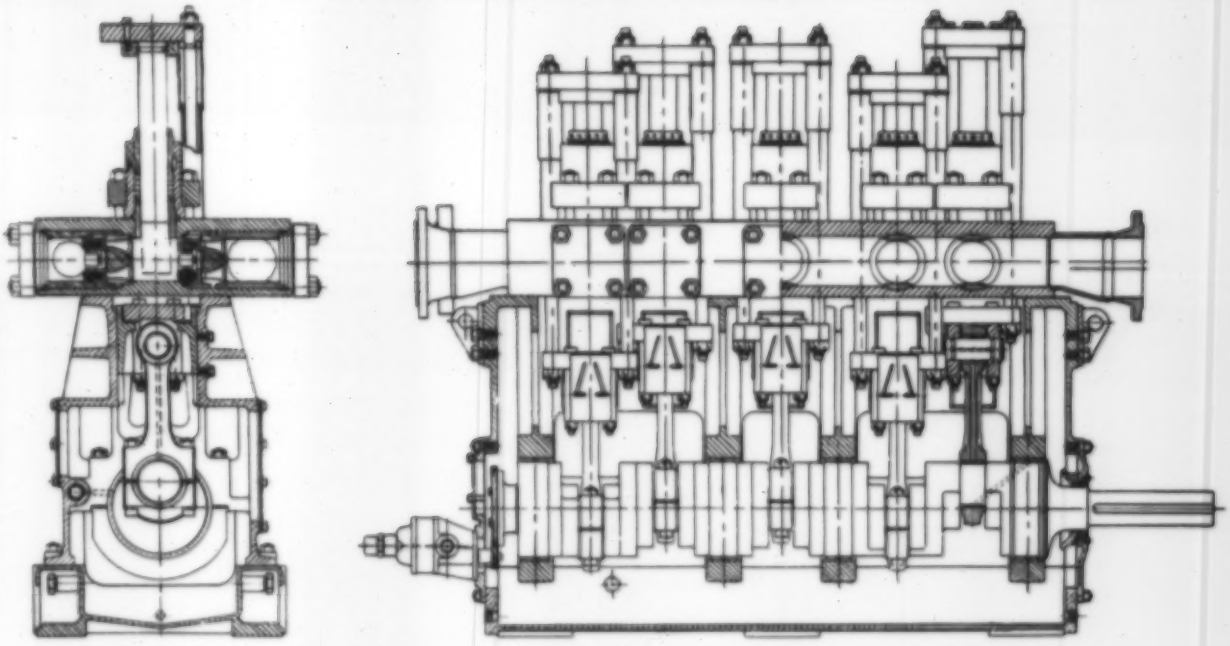


RECENT additions to a line of high-pressure pumps are five and seven-plunger models having maximum capacities ranging from 43 gpm at 5300 to 525 gpm at 680 psi. Interchangeable plungers make this wide range of capacities possible from only four basic pumps. Manufactured by Worthington Corp., the pumps are intended for use with large hydraulic presses, pipeline pumping and similar applications.



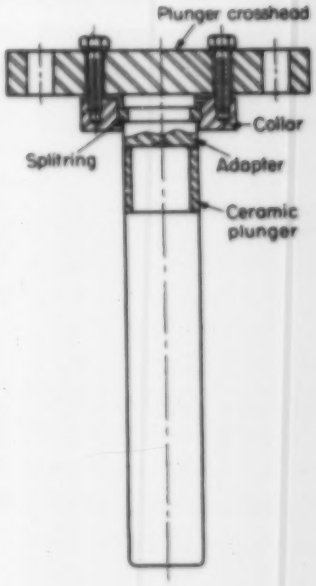
Plunger pump flow characteristically varies with crank angle to create a pulsating discharge. However, the use of multiple plungers and properly staggered crank throw angles produces an output which is very nearly constant. In the case of the five-plunger pump, the variation is 7.1 per cent. Variation with seven plungers is only 3.6 per cent.

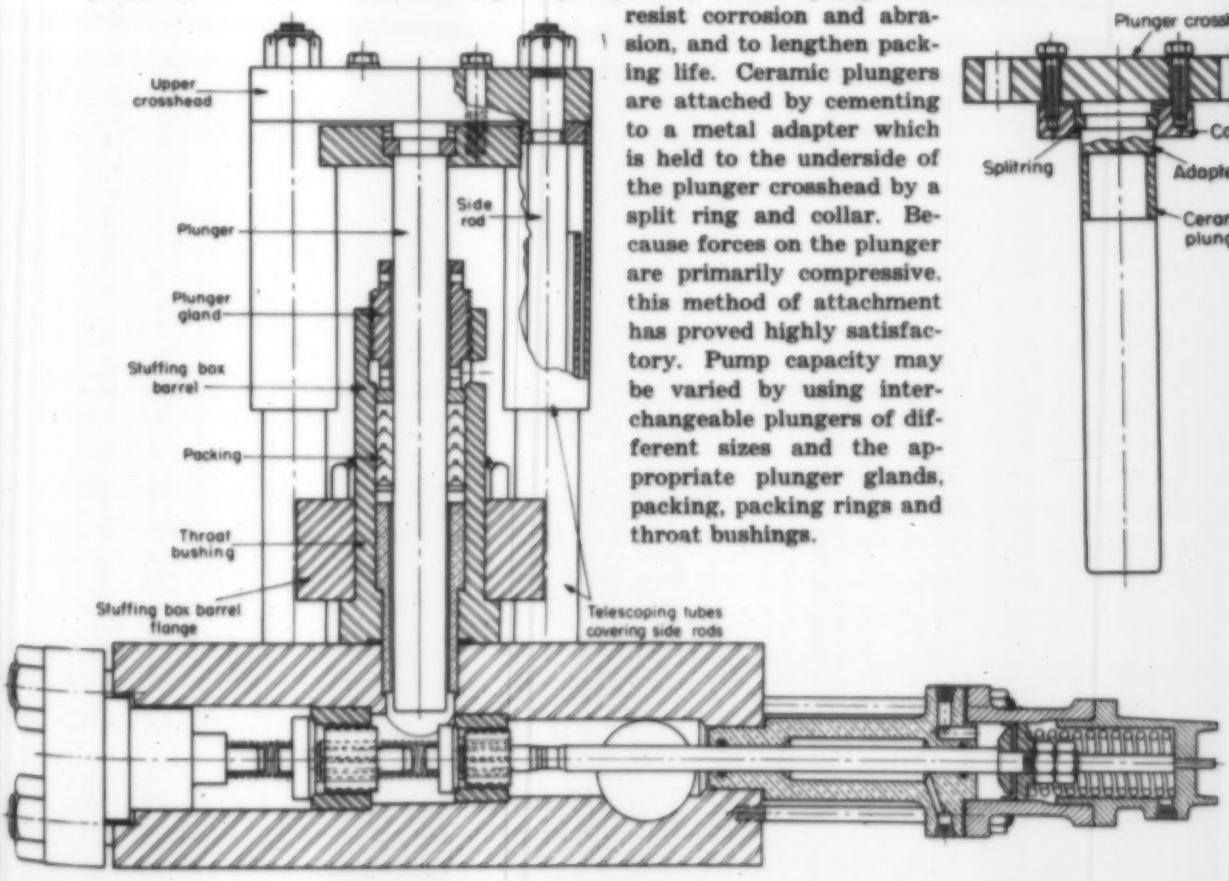
Plungers Allow Pump Capacity Changes



Construction details of the pumps include four shim-adjusted main bearings; full pressure oiling of bearings, crossheads and guides; full-flow oil filter; and crankshaft-driven lubricating-oil pumps. Removable panels give easy access to valves and the interior of the crankcase for servicing.

Plunger material is either Colmonoy-coated (hard-faced) metal for high pressures, or solid ceramic for high capacity. The ceramic plunger is said to resist corrosion and abrasion, and to lengthen packing life. Ceramic plungers are attached by cementing to a metal adapter which is held to the underside of the plunger crosshead by a split ring and collar. Because forces on the plunger are primarily compressive, this method of attachment has proved highly satisfactory. Pump capacity may be varied by using interchangeable plungers of different sizes and the appropriate plunger glands, packing, packing rings and throat bushings.





How to select and apply

Electrical Connectors

for power circuits

Separable electrical connectors can often help satisfy several design objectives — convenience, portability or mobility, flexibility.

Connectors provide these features in two kinds of circuits — power and signal.

Connectors for power circuits are discussed in this article; those for signal circuits will be covered in a future article.

By Laurence D. Shergalis
Assistant Editor, Machine Design

MOBILITY and flexibility of electrical equipment may often require means for quickly disconnecting electrical power and control wires.

The need for portability or mobility is obvious in household appliances, office equipment, and machinery such as welders, air compressors, small tools, etc. Merely "pulling the plug" often permits the unit to be moved readily from place to place.

Electrical connectors are essential in providing flexibility from a number of viewpoints. Quick interconnection of circuits of control panels and switchboards, for example, requires convenient connection means. Servicing or maintenance of equipment is often aided by the use of connectors. This is particularly true, for example, when continuity of service requires rapid replacement of faulty components. With properly chosen connectors, components can be replaced in a fraction of the time necessary to unsolder or unscrew wire connections, *Figs.* 1 and 2.

Electrical connectors are also often used in isolating electrically operated devices from gases or rarified atmospheres. For example, direct wiring through a pressurized container wall is not feasible. A connector will seal off the unit and still provide electrical continuity.

Electrical connectors may be divided into two categories: (1) power connectors and (2) signal circuit connectors. This article will deal with power connectors. A future article will consider connectors for signal circuits and special applications.

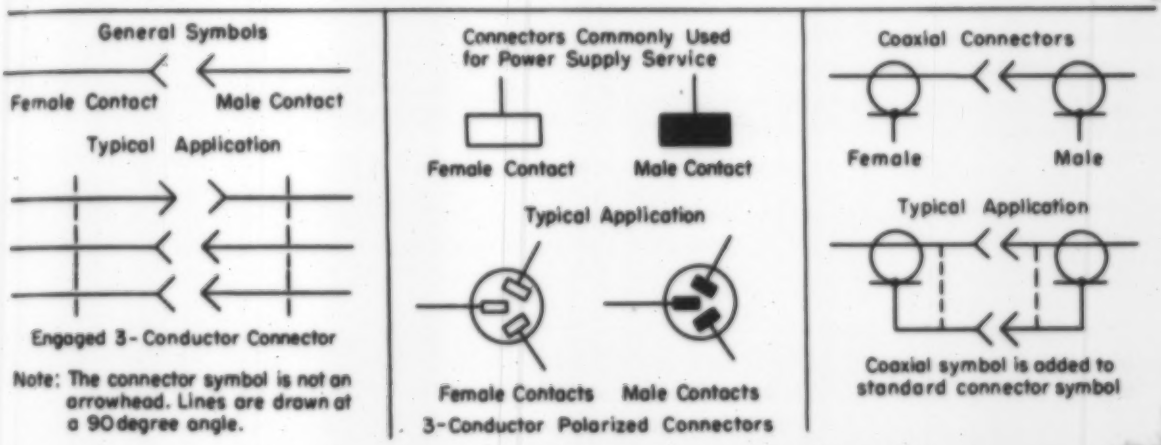
Application Requirements: Power connectors are ordinarily more rugged, larger and heavier than signal circuit connectors. Signal circuit connectors, however, generally carry many more contacts. Their normal current carrying capacity is usually in the milliampere range, while many power connectors are designed to carry loads of the order of hundreds of amperes.

Power connectors generally connect the equipment to its source of operating power. Probably the most common type is the ordinary household appliance plug and receptacle. Vacuum cleaners, radio and television sets, to name a few, must be equipped with this simple connecting device, called a cap, to satisfy the requirements of mobility. Caps are also used to connect lighter industrial equipment as in the test setup shown in *Fig.* 3.

Three types of two-wire power connectors are shown in *Fig.* 4. The male motor-base receptacle is made to accept a special power cord. This type is commonly used on electronic chassis as a power input connector. The outlet receptacle is provided with coupling-ring threads for locking. Its mating unit is the male plug also shown in *Fig.* 4.

Where higher currents are being handled, such as might be encountered with a household electric iron, a heavier duty attachment plug receptacle is provided on the appliance. A separate power cord set having a female attachment plug on one end

Graphic Symbols for Electrical Connectors



— from American Standard Graphic Symbols for Electrical Diagrams Y 32.2-1954

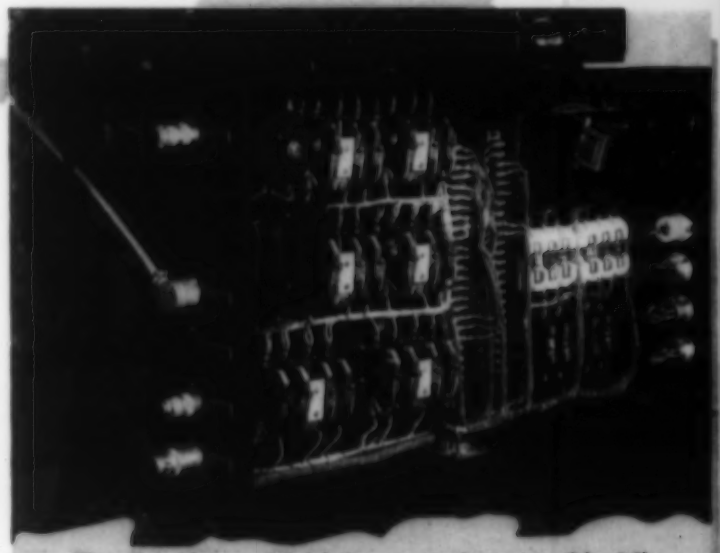


Fig. 1—Above—Multiple connections to this Mitchell background projector control box are made with detachable electrical connectors. Replacement of the control box or one of the components connected to it merely requires disconnecting the plug and removing the mounting bolts

Fig. 2—By use of the circled connectors, the cooling fan for this American Optical Co. slide projector can be replaced without unsoldering or unscrewing wire connections

and a male cap on the other is required. One advantage of this arrangement is that the appliance need not be disassembled if the power cord is damaged. A switch may also be incorporated in the female attachment plug.

Most domestic caps and plugs are rated at 660 watts and are safe at operating voltages up to 250 volts. Appliance plugs and receptacles generally are rated somewhat higher. An average rating is about 1300 watts at voltages up to 250 volts.

Connectors for equipment operated from a two-wire dc source must be the polarized type to insure a connection of the proper polarity. Of course, some applications, such as heating and lighting, are exceptions.

Safety requirements often dictate the use of a third grounding terminal. Much equipment is operated under conditions where the operator may complete the ground from an accidentally energized metal part on the machine to a damp floor. A third conductor must be provided in the power cord to connect the metal parts of the device to the ground contact of the power connector. A third ground socket is provided at the receptacle.

Most electric ovens, ranges and dryers operate from a source supplying two different voltages. This power source may be a center-tapped transformer secondary supplying single-phase ac at full and one-half secondary voltage. Direct current, properly divided, is also used. In either case, a three-wire receptacle and connecting plug are re-

quired. Usually because of the higher voltages involved, insulation and spacing between pins must be increased. This results in a larger, heavier connector. Since the neutral wire, or center tap, is usually grounded, extra grounding of the equipment is not necessary. All of these three-wire caps and receptacles must be polarized to insure proper connection. Typical three-wire polarized cable connectors are shown in *Fig.* 5. Cable clamps are provided to avoid strain on the wire terminals.

Ratings of average three-wire domestic appliance connectors and receptacles are as high as 500 amp at 250 volts. Smaller caps accommodating two No. 8 and one No. 10 wire are rated at 35 amp at 250 volts. Caps taking two No. 6 and one No. 8 wire have the 50-amp rating.

Heavy movable equipment such as mining machinery and welders operate on higher voltages at higher currents than the previously discussed light-duty equipment. Also, operating conditions are usually more severe. Often such equipment operates under conditions of extreme vibration, moisture or corrosive atmospheres. Connectors for this type of service are distinguished from others by these characteristics:

1. Spacing between contacts is greater due to higher operating voltages resulting in a larger connector.
2. Contact size is increased because of the necessity of carrying higher currents.
3. Metal shells are ordinarily required for shielding in explosive atmospheres and for protection where rough physical handling is expected.
4. Locking of the plug to the receptacle or lock-of two cable plugs to each other when mated may be provided to eliminate accidental disconnect.

In wiring, general practice is to use a female or enclosed-contact connector as the normally energized cable end or receptacle. This practice prevents accidental touching of exposed live contacts or accidental shorting of contacts. Male plugs and receptacles are used as the normally de-energized half of the connector.

In matching a connector to the requirements of an application the following factors should be considered:

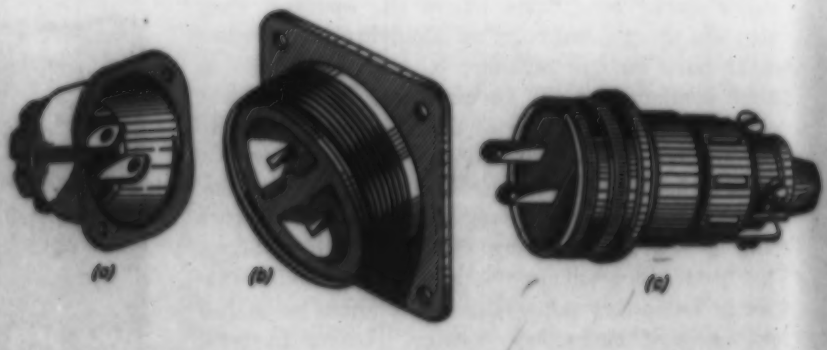
1. Number of circuits
2. Current rating
3. Voltage rating
4. Power line frequency
5. Connector mounting
6. Environmental conditions
7. Utility

Number of Circuits: One of the first items to consider in the selection of power connectors is number of contacts. Naturally, a minimum of two contacts is needed to supply ungrounded single-phase ac or a single voltage dc. Addition of a ground connection requires one more contact.

Generally, ac motors rated at 3 hp and higher are three-phase and usually operate at 230, 460 or 575 volts. They may require a three or four-con-

Fig. 3—Small two-wire domestic type receptacles are the power outlets for this compact ac distribution box. Caps adequately handle the low current necessary to drive these small motors

Fig. 4 — Three types of two-wire power connectors. Receptacle *a* is commonly used for power input to electronic equipment and may be chassis or panel mounted. Power outlet receptacle *b* may be panel mounted and is threaded to accommodate a locking ring. Male plug *c* makes up a complete connector assembly with the female power outlet receptacle. These connectors are rated at 125 volts at 15 amp and 250 volts at 10 amp



ductor power cable, depending upon the way in which the three-phase transformer secondary is connected. A wye system with a grounded neutral or a delta system with an additional ground both require a four-wire input cable and four-contact connectors. Two-phase three-wire power circuits also require provision for four wires. Some two-phase four-wire circuits require only four wires while others may require five.

Connectors are commercially available for ac power service having up to five contacts and ratings up to 400 amp. A standard voltage rating is 600 volts.

Portable plugs for heavy-duty dc applications are available at ratings up to 450 amp. Wire size at this rating is 750 million cir mils. These dc plugs accommodate two power wires and one ground wire.

One type of high-current dc connector is illustrated in *Fig.* 6. Rated at 1500 amp, this connector is designed for storage battery and external power connections. Aircraft power supply and stationary engine starters are also among its applications.

Certain types of equipment require multicontact connectors capable of handling more than a single source of power. Electronic equipment, for example, often requires both dc and ac power input. Vacuum tube filaments generally require a low voltage ac supply while plate voltage is normally much higher at lower currents. Filament voltages are of the order of 6.3 or 12.6 volts for most applications. Current requirements average only a few amperes, although the number of vacuum tubes supplied and their type determine the rating. Usually more than one filament transformer is used if the current requirements become excessive. Therefore, for each filament voltage source, anoth-

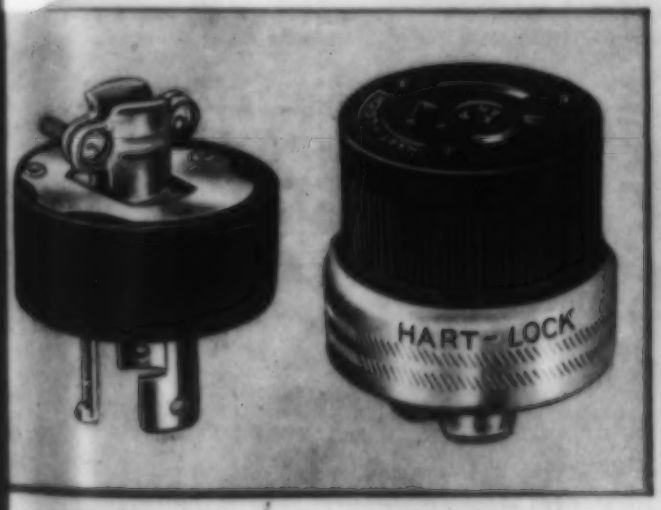
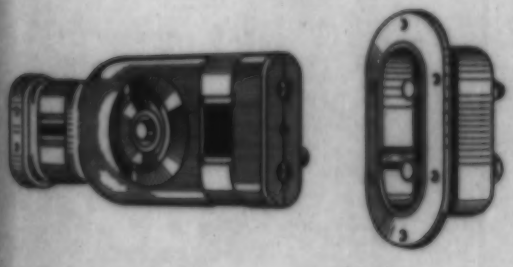


Fig. 5—Above—These three-wire cable connectors, are polarized to insure correct engagement of contacts. They are rated at 20 amp, 250 volts ac or dc or 10 amp at 600 volts

Fig. 6—Below—One type of high-current power connector used as an external power connection for aircraft and stationary engines. Its maximum rating is 1500 amp



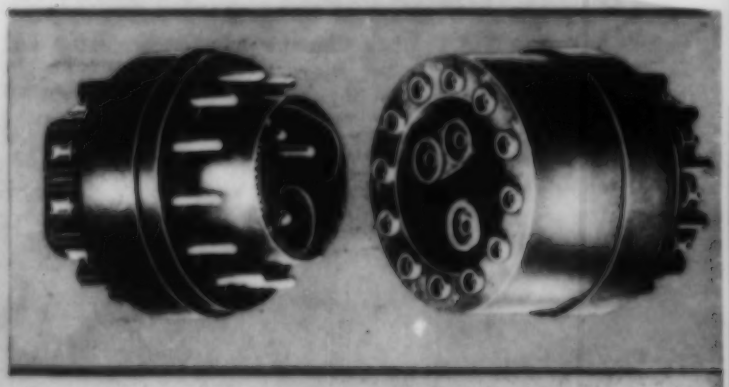
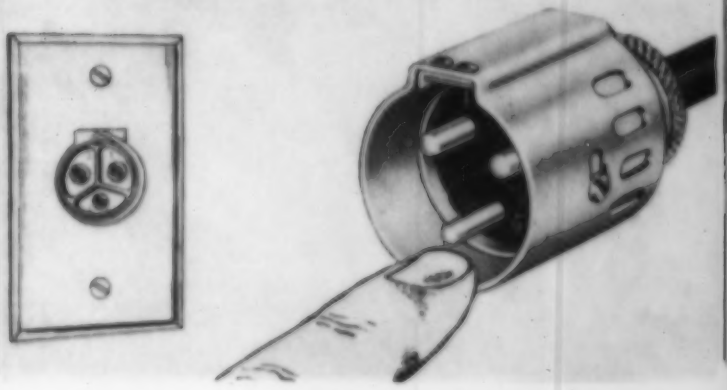


Fig. 7—Above—Fifteen low-voltage contacts and three high-voltage contacts are provided in this connector insert. Breakdown rating between the center contacts is about 10,000 volts. Current rating is 2 amp for the center contact and 20 amp for each of the contacts in the outside row

Fig. 8—Below—Arc barriers are provided on the insert of this three-wire connector to increase the effective distance between contacts. Voltage rating of the connector can be correspondingly increased without increasing size



er two contacts must be made available in the connector.

Plate supply voltage depends upon design requirements, but may range from less than 90 volts dc to several thousand volts. Many electronic circuits require more than one plate voltage. Where several dc voltages are needed, a connector pin is required for each plus one ground pin. It may be possible to obtain the ground return through the cable shield and the connector shells. Ordinarily, however, shielding of power cables is only required under special conditions. Shielding merely to provide a ground connection may be more expensive than providing an additional connector contact and cable conductor. One type of connector insert that may be used for both high and low voltages is shown in *Fig.* 7. The three inside high-voltage contacts are removable if necessary.

Current Rating: Contact size determines the current carrying capacity of the connector. Undersize overloaded contacts may become hot and damage insulation. There is also a possibility of severe arcing and burning as the plug is being disconnected. Not only is damage to the connector an inevitable result, but there is a possibility of human injury.

Safe current carrying capacity is specified by each manufacturer. Wire size recommendations of cable conductors for use with a particular connector are also usually specified. Both the ampere rating of the connector and the cable assembly should be considered.

Allowable safe current carrying capacity of a few types of insulated conductors is given in *Table* 1. Data are based on an ambient temperature of 86 F with not more than three conductors in a raceway or cable. A complete listing of current-carrying capacities for all commercial types of insulation may be found in most engineering handbooks.

Contact material as well as contact size determines the current carrying characteristics of the connector. Steel, for example, heats readily and is rated at relatively low currents. Copper or brass contacts are most common for high current service. Other contact materials include beryllium copper

Table 1—Allowable Current Carrying Capacities in Amperes of Insulated Conductors*

Wire Size	Rubber Types R, RW, RU, RUW (14-2) Thermoplastic Type T, TW	Rubber Type RH	Paper Var Cam Type V	Impregnated Asbestos Type AI (14-8) Type AIA
14	15	15	25	30
12	20	20	30	40
10	30	30	40	50
8	40	45	50	65
6	55	65	70	85
4	70	85	90	115
2	95	115	120	145
0	125	150	155	200
00	145	175	185	230
0000	195	230	235	310
250	215	255	270	335
400	280	335	360	450
500	320	380	405	470
600	355	420	455	545
750	400	475	500	620

*Not more than three conductors in raceway or cable

Fig. 9—Left—This switchboard installation of 250 receptacles makes both ac and dc power available to machine-tool testing stations. A wide range of ac and dc voltages are available as well as ac at various frequencies

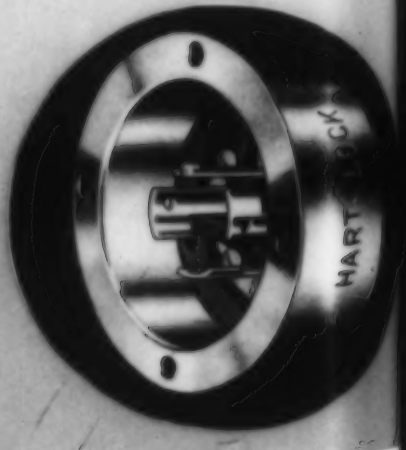


Fig. 10—Right—Rear panel mount which eliminates contacts projecting from the front of the panel

and tinned phosphor bronze.

Type of insulation and overall design also determine heat dissipation characteristics—another factor that may limit load current.

Voltage Rating: Contact spacing as well as the type of insulating material is important in determining the voltage flashover point. Here again, manufacturers' specifications govern the choice of a particular plug or receptacle. An important point to remember is that published specifications are usually obtained under ideal test conditions. Many factors may be introduced to reduce voltage ratings. Dirt, contaminants in the atmosphere, or dampness increase possibilities of arcing between contacts. Possibility of operation at high altitudes under conditions of rarified atmosphere should be considered. At high altitudes, corona forms to reduce the effective spacing between contacts. Connectors designed with arc barriers, *Fig.* 8, effectively increase spacing between contacts and permit higher voltage operation.

Voltage ratings for dc are up to 30 per cent higher than rms ac voltages. At lower voltages the difference is much less than at higher voltages. Therefore, to specify a connector to operate from both ac and dc, the connector should be chosen on the basis of the dc operating voltage. This difference can usually be ignored at voltages below about 50 volts. *Table* 2 gives a comparison of the ac and dc operating voltage limits.

Table 2—Comparison Between AC and DC Limiting Operating Voltages

DC	AC*
70	50
200	150
500	275
650	350
750	500
3000	2100

*rms

Power Line Frequency: Operation of ac circuits at common power supply frequencies does not normally require special connector shielding. The common 60 cps supply frequency presents no problems. A standard aircraft power supply frequency is 400 cps, which is still not in the range where special shielding and insulation need be considered. Connectors for operation in the radio frequencies—15,000 cps and higher—will be discussed in the article dealing with signal circuit and coaxial connectors.

Connector Mounting: Major types of receptacle mounts are:

1. Front panel
2. Rear panel
3. Machine and wall
4. Wall outlet box

FRONT PANEL MOUNTING is a common method of fastening connectors to switchboards, control panels and electronic equipment. The most common type of front-panel connector requires a large panel hole through which the conductors pass and four smaller mounting holes to fasten the supporting surface of the shell. Because of the large contact area between the shell and the panel, a strong solid mount results. This is especially desirable in switchboard service where cables may be connected and disconnected frequently. An example of panel-mounted receptacles is the switchboard installation, *Fig.* 9.

REAR PANEL MOUNTING shells, *Fig.* 10, are similar to front panel shells except that the insert

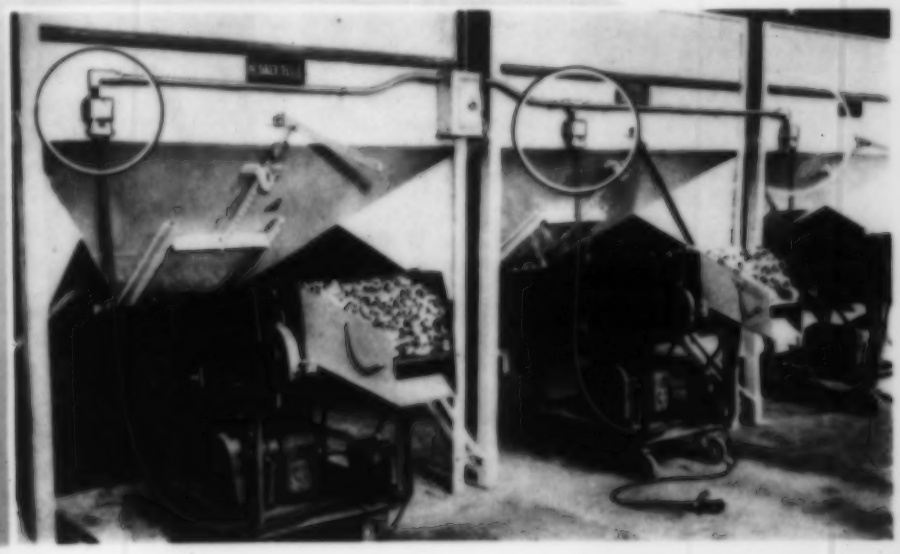


Fig. 11 — Wall-mounted receptacles provide power outlets to operate these mobile conveyors at the supply bins in a metal processing plant

Definitions

Cable Clamp—A device provided on certain types of connectors to grip the cable and prevent its pulling out of the plug. Tension on the cable is taken up at the cable clamp rather than on the internal connections.

Cap—Domestic type light-duty male plug.

Connector—Receptacle and mating plug, or two mating cable plugs.

Contacts—Parts of the connector assembly that join to provide electrical continuity. They may be either the pin or socket type.

Coupling Ring—Free turning threaded ring mounted around the outside of the shell. Its purpose is to lock the plug to its receptacle or to another plug.

Female Connector—Connector half with enclosed contacts and generally used as the normally energized half of the connector assembly.

Grounding Pin—Separate grounded contact used only to provide a ground connection through the connectors. This pin is often slightly longer than the energized contact pins so that the ground connection will be maintained until after the energized contacts are disconnected.

Insert—Internal part of the plug or receptacle that insulates the contacts and holds them in place.

Male Connector—Connector half with exposed or pin contacts and generally used as the normally de-energized half of the connector assembly.

Pilot Pins—Guides used on large connectors to facilitate engagement.

Pin Contacts—Male contacts in the form of solid pins.

Plug—Part of a connector normally removable after uncoupling. It consists of a shell surrounding pin or socket contacts. An insert holds the contacts in place.

Polarized Connectors—Connectors provided with a keyed method of mating to insure proper engagement of the male and female contacts. Keying may be either by means of a slot or lug on the shell, or by contact arrangement or size.

Receptacle—Part of a connector that is normally fastened to a supporting surface. It couples to the plug and contains pin or socket contacts.

Shell—Outer housing of the plug into which the contacts are assembled.

Socket Contacts—Female contacts which are tubular, usually slotted.

neck passes through the panel from the rear. The supporting surface is fastened to the rear of the panel. Some commercial types of receptacles may be mounted from either the front or the rear. Rear panel mounting permits the insert to extend behind the panel rather than in front. Long extensions out of the front panel may be avoided in this manner, thus saving space.

MACHINE OR WALL MOUNTING involves fastening the receptacle to the equipment or a wall by means of a surface mount. Essentially, the connector insert and shell are parts of a box with the entire assembly provided with mounting holes. This type of mounting is used where panel space is not provided or is not required. Machine and wall mounting receptacles may be fastened to any surface where through-mounting is not practical. Brick walls and thick cast-iron surfaces are two possible examples of locations at which this type of mount may be effectively utilized. Wall-mounted receptacles are used to provide power outlets for the mobile conveyors show in *Fig.* 11.

Wall-mounted connectors are available in multiple-outlet styles for use as power distribution points for several machines. Ratings are as high as 100 amp at 600 volts. Multiple-outlet wall-mounted receptacles provide power to the bank of welding units illustrated in *Fig.* 12.

WALL OUTLET BOX mountings, *Fig.* 13, are made to fit in standard size power outlet boxes. Inserts for outlet box mounting are available to accommodate up to eight No. 4 wires. Maximum rating for most commercially available units is 600 volts. Single or multiple outlets are possible in this mounting style.

Modifications of the preceding mounting types

Fig. 12—Multiple outlet boxes enable all of these welding units to operate simultaneously. Any unit may be removed from this area quickly by merely removing its plug

are possible. For example, one modification involves the use of a chassis-mounted connector used in conjunction with electronic equipment, *Fig.* 14. As the chassis, which is mounted in a drawer arrangement, is slid into its compartment, the connector fastened to the rear of the unit couples with a mating connector fastened permanently to the rack. This type of connection finds more general use in signal circuits.

Many instances occur where space does not permit receptacle mounting. In these cases, the power cable is brought out of the unit and terminated with a cable connector. Cable connector inserts are usually made to be interchangeable with receptacle inserts. On the forming press, *Fig.* 15, use of cable connectors proved to be convenient.

Clamping of the cable is necessary when using cable connectors. A clamping nut is usually provided to compress a rubber bushing that centers and grips the cable. Split-ring cable clamps are also commonly used. A third type of cable clamp consists of a rubber or neoprene sleeve tightly fitted to the cable and plug. All of these types of cable clamps are readily removable.

Environmental Conditions: Service conditions to be considered in choosing power connectors include:

1. Moisture
2. Temperature
3. Dust and dirt
4. Corrosive atmosphere
5. Explosive atmosphere
6. Rarified atmosphere
7. Vibration
8. Rough physical treatment

MOISTUREPROOF CONNECTORS are available in two types. One type is completely waterproof and will operate satisfactorily when totally immersed in water, ice or mud. Sealing is by means of a resilient gasket at the plug and receptacle mating surfaces and a grommet under the cable clamp. Rubber sleeves fitted around the cable also serve to seal the plug. Tight sealing may be further insured by fitting a clamp around the sleeve to hold it in tight contact with the plug shell. Some commercially available types use O-ring seals. A cutaway drawing of a completely waterproof connector, *Fig.* 16, illustrates the use of gaskets and grommets to

Fig. 13—Left—A typical two-wire wall outlet box mounting receptacle. These units are made to fit standard outlet boxes

Fig. 14—Below left—This type of connector may be used with drawer mounted equipment, such as the electronic chassis of computers. One part of the connector is mounted on the chassis, the other fastened to the rack. The entire unit is disconnected by pulling the chassis out of its compartment

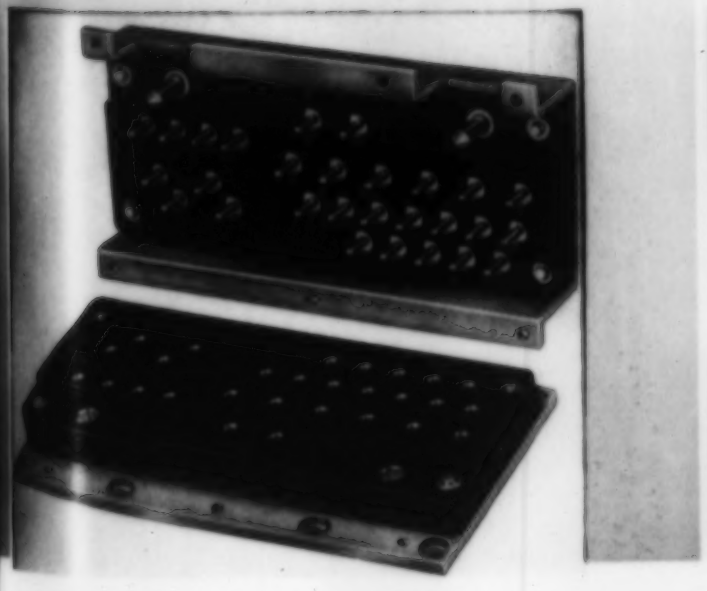
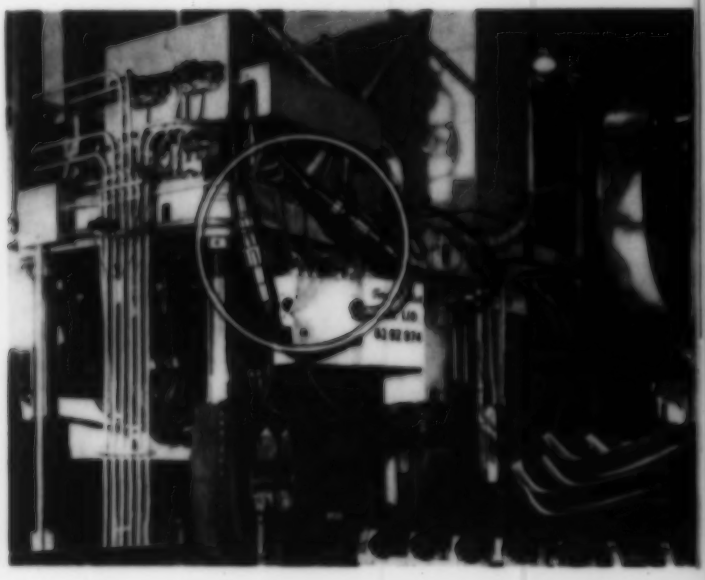


Fig. 15 — Below — Limited space for receptacle mounting often requires the use of cable connectors as on this forming press in an automobile plant



enable the connector to withstand complete submersion.

Connectors for mining machinery are often subject to complete submersion. Shipboard service also demands waterproof connectors, especially with hoist and conveyor motors, or floodlight and searchlight connections on deck. Ship-to-shore power cable connectors and shipboard power receptacles should be sealed against water to prevent both arcing and corrosion of contacts. Two types of ship-to-shore power watertight connectors are illustrated in *Fig.* 17.

A second type of moistureproof connector guards only against spray or precipitation. Suitable for most outdoor applications, this weather-proof type of connector finds its greatest use in trucks, trailers, railway and marine service, temporary outdoor lighting, industrial applications where dripping water is encountered, etc. One method of moistureproofing cable connectors is shown in *Fig.* 18. Here a rubber cap fits over the junction of the connectors when assembled.

TEMPERATURES to which connectors and receptacles are subjected often become severe. Inserts of high-temperature connectors are made of a ceramic material enclosed in a steel shell. Connectors for high-temperature use are tested to 2000 F.

Any application in which power must be carried in case of sudden high temperature conditions requires fireproof connectors. For examples, power is supplied to aircraft feathering motors and some engine components through a connector located on a firewall. In case of an engine fire, failure of power to the propeller feathering motor might be disastrous. Certain jet engine and gas turbine applications also require connectors capable of withstanding high heat continuously.

For applications not requiring fireproof connectors, most manufacturers specify a safe tempera-

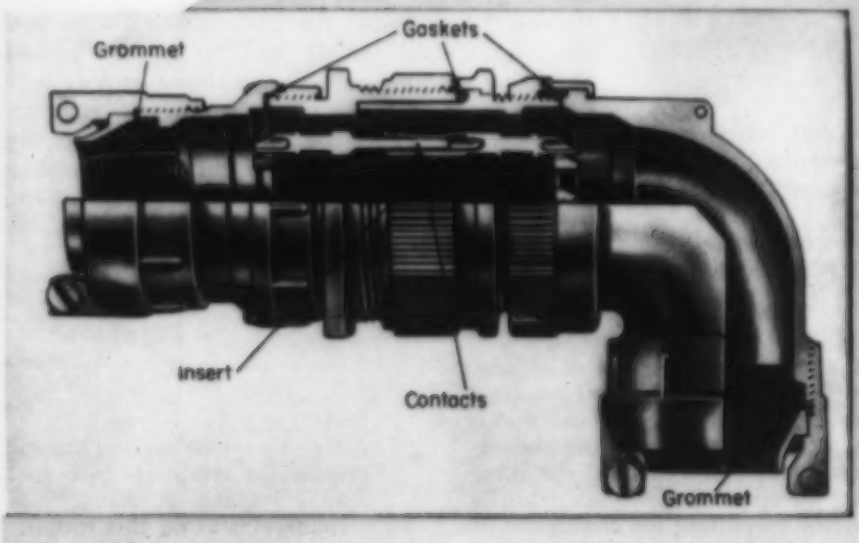
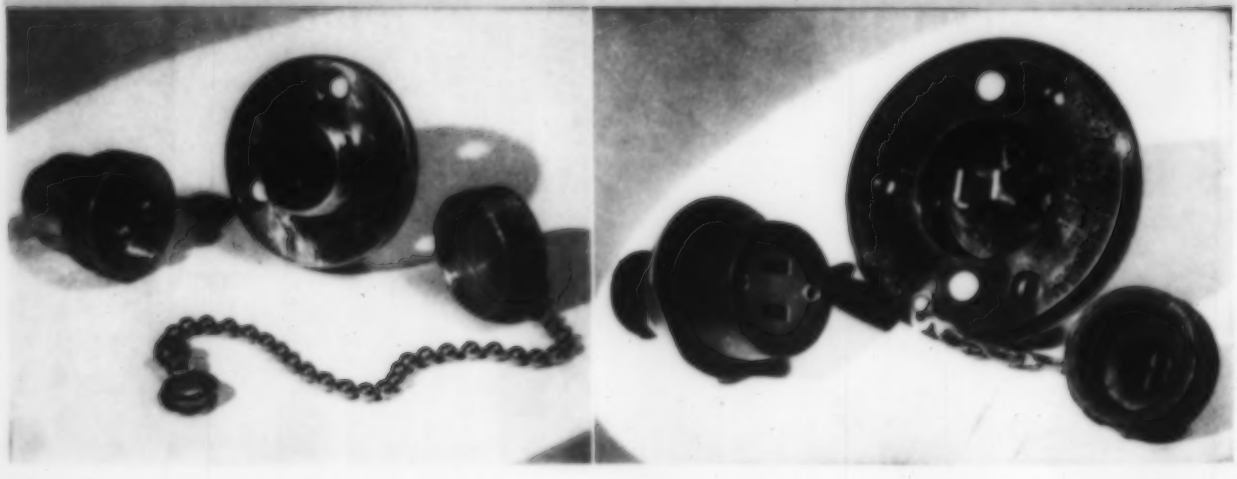


Fig. 16 — Complete waterproofing of connectors may be accomplished with gaskets and grommets as illustrated in this cutaway drawing

Fig. 17—A low-voltage watertight connector, left, for ship-to-shore power connection can be completely sealed by the cap when not in use. The 110-volt, 25-amp connector, right, is sealed by the rubber plug when disconnected



ture operating range. Insert material, of course, is the determining factor. A commonly specified temperature range for nonfireproof connectors is 55 C to 85 C.

DUST AND DIRT in connectors will result in arcing contacts and eventual damage to the unit. However, while mated, plugs and receptacles ordinarily will not be susceptible to dirt. But if receptacles or cable plugs are to remain unconnected for any period of time, they should be provided with dust caps or dust covers.

One type of dust cap screws on over the face of the connector on the coupling ring threads. Another type utilizes a spring-loaded hinged cover that closes when the connector is disconnected. The screw-on type may be made watertight with the addition of a resilient disk in the cap. Dust caps also act as protection against live circuits.

Hinged dust caps are often provided on switchboard connectors, *Fig.* 19.

CORROSIVE ATMOSPHERES affect the pin and socket contacts of the connector and the outer shell. A sealed type of connector will effectively limit corrosion to contacts. Either a watertight or a pressure type connector will perform well under conditions of corrosive atmospheres. Special insulators are available which resist nitric acid fumes and fuel oil.

Corrosion damage to outer shells is minimized by plating. High resistance to corrosion may be obtained by cadmium plating aluminum with a chromate conversion coating. This type of coating also has the advantage of permitting good electrical conductivity of the shell. Smaller shells are often chrome plated to reduce corrosion.

EXPLOSIVE ATMOSPHERES require a connector

Fig. 18—A rubber cap seals the junction of this four-contact locking connector to provide resistance to moisture

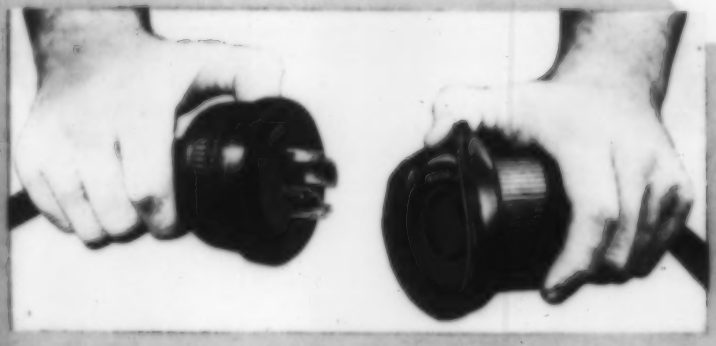


Fig. 19—Hinged dust caps are provided on these switchboard receptacles to keep out dust and to prevent accidental contact with live circuits

Fig. 20—Construction details of a circuit-breaking power connector. This connector may be disconnected without first de-energizing the circuit since the arc is snuffed inside the enclosed arcing chamber. Current ratings of this type run as high as 100 amp

Fig. 21—Twist-locked connector in its locked position, showing how the contacts engage

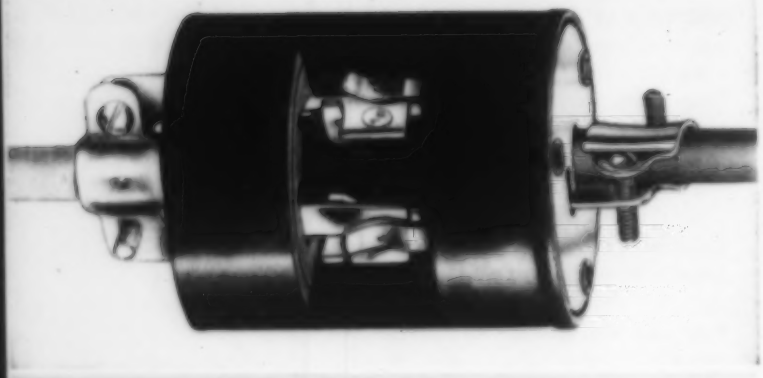
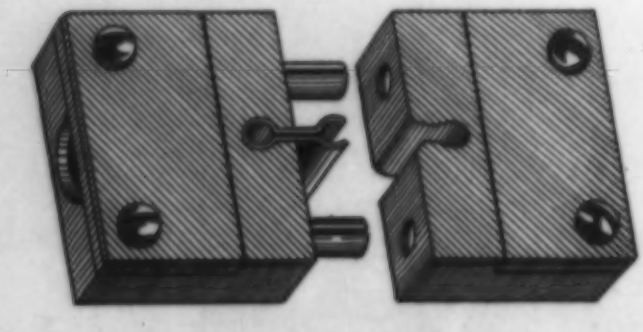
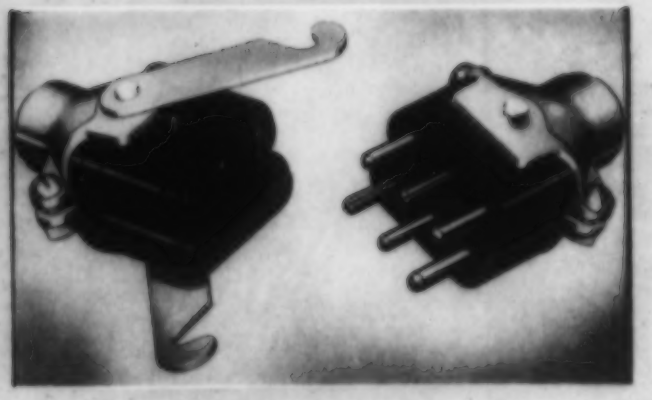
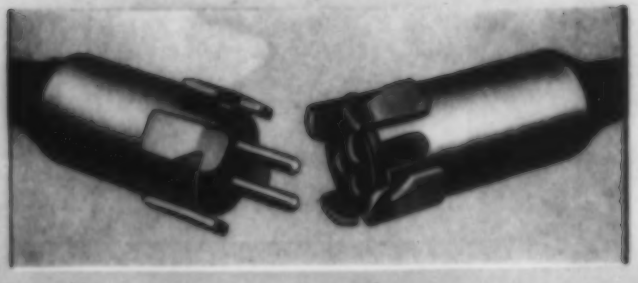


Fig. 22—Three methods of locking power connectors together to prevent accidental disconnect







sealed against gases and built to eleminate loose fits between pins and sockets which may cause arcing. Special explosionproof connectors are available in which clearances have been held to extremely close tolerances.

Circuit-breaking power receptacles are another form of explosion-proof connector. The arc formed when pulling the plug is extinguished in an arcing chamber. Should the plug be pulled while the circuit is energized, there is no danger of bodily injury or property damage due to flashover. The cutaway drawing, *Fig.* 20, illustrates the construction of a typical circuit-breaking power connector.

RARIFIED ATMOSPHERES present special problems. Because of low pressures and corona formation, connector voltage ratings are considerably reduced. Condensation is an additional problem caused by low pressures at high altitudes and possible rapid temperature variations between ground and high-altitude temperatures. Pressure-sealed connectors are the answer. Three types are generally available:

1. Pressurized connectors that are intended for use as a pressure-tight feed-through for power circuits passing through bulkheads or pressure barriers.
2. Sealed connectors that provide a greater degree of leakage resistance than the pressurized type.
3. Hermetically sealed connectors that are a special class available for use where no leakage whatsoever is permissible. Inserts, steel shells and contacts are fused to make a permanent seal.

VIBRATION may separate friction type connectors, causing accidental power failure. In some cases vibration may also damage the connector assembly itself. Insert material fused to the contacts and shell may break away, allowing contacts to loosen and possibly short. However, most commercially available plugs and receptacles have been designed to withstand vibration and shock effects. Manufacturers' specifications ordinarily will serve as a satisfactory guide in the choice of a connector that will not be damaged by vibration.

Various mechanical locking means are available to prevent connectors from pulling apart. Probably the most common method of locking a connector into its receptacle is the twist-lock type, *Fig.* 21. The male connector is inserted into the receptacle and given a clockwise twist. This action locks it and prevents the plug from being vibrated loose. It is impossible to pull the connector out of its socket by a direct pull on the cable. A simple reverse twist unlocks the connector.

Another common method of locking is the threaded coupling ring. To prevent the ring from unscrewing, a safety wire is used. Square-cut spiral threads are also used to provide good locking and easy uncoupling of large heavy-duty connectors.

Another coupling method often used on large power connectors is a simple chain and hook arrangement. Here, one end of the chain is provided

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Frank W. Morse Co. ..... Boston, Mass.
National Electric Products Corp. ..... Pittsburgh, Pa.
North American Philips Co. Inc. ..... Mt. Vernon, N. Y.
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Rodale Mfg. Co. Inc. (*Figs.* 18, 21) ..... Emmaus, Pa.
Scintilla Magneto Div., Bendix Aviation Corp. (*Fig.* 16) ..... Sidney, N. Y.
Soreng Products Corp. ..... Schiller Park, Ill.
C. H. Stevens & Co. Inc. ..... Cornwall Bridge, Conn.
Titeflex Inc. ..... Newark, N. J.
Union Insulating Co. Inc. ..... Parkersburg, W. Va.
U. S. Components Inc. ..... New York, N. Y.
United States Gasket Co. ..... Camden, N. J.
Vibro Mfg. Co. ..... Woodside, L. I., N. Y.
Westinghouse Electric Corp. ..... Pittsburgh, Pa.
Whitney Blake Co. ..... New Haven, Conn.
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Fig. 23—Power connector made to withstand rough handling in a mining operation at Enoco Collieries. Connectors this size are available at dc ratings up to 450 amp

with a snap hook that engages a metal eye on the receptacle or other cable. Various types of bayonet locks and spring detent type locks are commonly used on power connectors. Many types of mechanical latching devices are also available. Three methods of mechanical locking are shown in *Fig.* 22.

Friction-held cable connectors having no separate locking means are commonly held together by merely tying the cable around the connectors. Tension on the cables will be taken up by the knot rather than the connectors. Although it cannot be used with heavy power cables, this method is a good emergency expedient where accidental disconnect must be prevented.

ROUGH HANDLING of connectors requires shell materials and platings that resist dents and scratches. Special attention must be given to cable clamps and internal wire fastening to minimize the danger of cables being pulled out of their connectors. Where there is a possibility of wires being broken internally, solderless or screw-terminal pin connections should be specified. Broken wire replacement in screw type terminals is relatively simple compared to replacement of soldered connections. Soldering difficulties almost necessitate the use of solderless terminals with larger high-current capacity cables. *Fig.* 23 shows a connector designed to withstand rough handling.

Generally, many commercially available power connectors incorporate features enabling them to withstand service under a combination of environmental conditions. For example, many power connectors are waterproof, incorporate locking features, and are designed to withstand rough service. Certain combinations, such as a heat-resistant and pressurized connector, may require a special design. Often a compromise may be necessary. In some cases, relocation of a receptacle to reduce the effects of one type of environment may permit a commercially available type to be used.

Utility: Two important points with respect to utility are: (1) How frequently the device will be connected and disconnected, and (2) Under what conditions the equipment must be connected and disconnected.

Frequency of operation will largely determine the locking method specified. A simple twist-lock or quarter-turn coupling ring would be preferable to a long threaded coupling ring and a safety wire. Naturally, a simple friction-held connector is preferable to any locking type where vibration or shock is not a problem.

Operating conditions under which workmen normally wear heavy gloves determine the ease with which a connector can be operated. Cold weather or certain hazardous industrial operations fall into this class. Miniature connectors with small coupling rings may be difficult to remove. Another consideration would be certain types of power circuits that might require rapid disconnect in case of emergency. Complex unlocking means would certainly be out of the question. Also, the connector should be large enough, or be provided with a handle, so that it may be readily grasped and removed. Where many operations are required, such as in laboratory or test panel service, the type of connector shown in *Fig.* 24 is one answer.

Future Article: Factors in the selection and application of connectors for signal circuits and special applications will be discussed in a later article.

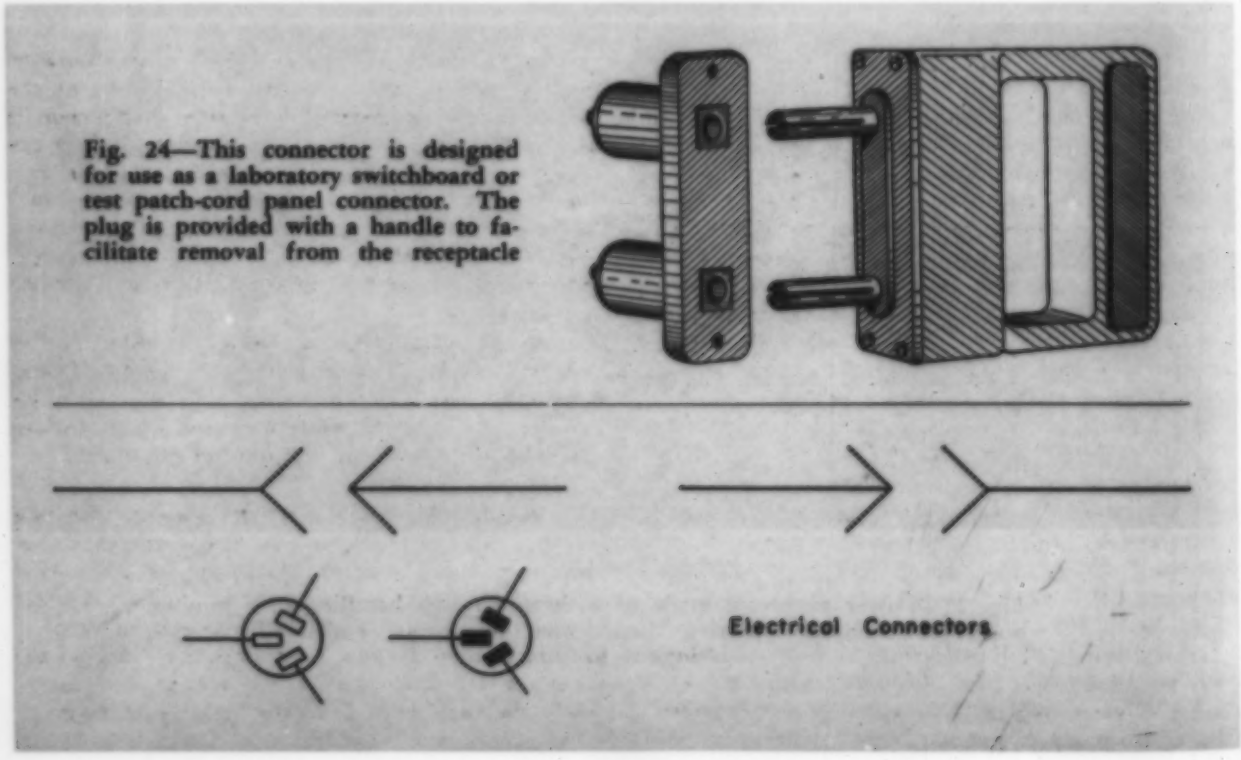


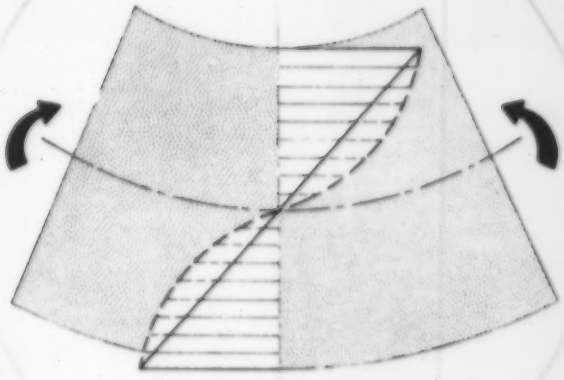
Fig. 24—This connector is designed for use as a laboratory switchboard or test patch-cord panel connector. The plug is provided with a handle to facilitate removal from the receptacle

A simplified method for determining

Flexural Strength

Based on graphical techniques and suitable for slide-rule calculations, this method offers a practical approach to:

1. **Determination of bending strengths for different materials and section shapes**
2. **Organization of analytical data for design analysis**



By L. H. Symes
Chief Stress Methods Engineer
Cleveland Pneumatic Tool Co.
Cleveland, O.

IN THE design of structural machine members, evaluation and comparison of strength-weight ratios of different materials may often depend on flexural, rather than tensile, strength characteristics. A typical case in point is that of aircraft landing gears where bending loads are of primary importance. To describe the flexural strength of a structural member, however, it is customary to use the so-called bending modulus of rupture. This modulus, which is defined as the nominal extreme fiber stress at failure, is a function of the cross-section shape and the stress-strain characteristics of the material.

It is usually necessary to determine the modulus of rupture whenever a new material is being evaluated. At the same time, however, a similar need may exist for many of the materials now in common use. In the application of hand-forged aluminum alloys, for example, values of ultimate tension, yield tension and ultimate elongation vary with billet size and grain direction.[1,2]

To facilitate rapid calculation of the bending modulus of rupture for different materials and section shapes, this article presents a simplified approach based on an extension of the Cozzone method[3] for determining flexural stresses in the plastic range. A simple closed-form expression is established for the modulus as a function of the principal material properties and the section factor, k. In the discussion to follow, the basic equations used in the simplified method will be developed first and then three practical problem examples will be worked out in detail to illustrate the procedure.

Local crippling has not been accounted for in this method or in the problem examples. Therefore, the results obtained are valid only for cross sections of sufficient wall thickness where failure will not occur by local crippling or buckling.

Basic Considerations: Cozzone's plastic bending theory[3] assumes a trapezoidal stress diagram with the ordinates s_o and s_m, where s_m is the actual extreme fiber stress and s_o is the stress intercept at the neutral axis, *Fig.* 1. The stress intercept s_o for each material was determined by Cozzone for a rectangular cross section, using a plotted stress-strain diagram based on minimum guaranteed properties.

[1]References are tabulated at end of article.

In contrast, the analysis presented here is based on the idealized stress-strain diagram shown in *Fig.* 2. This practice avoids the tedious job of first plotting a stress-strain diagram and then calculating, by numerical integration, the static moment of the area under the diagram about the neutral axis. Use of the idealized stress-strain diagram also has the definite advantage of introducing uniformity in bending modulus of rupture values.

Nomenclature

- A = Intercept of slope line of plastic stress-strain curve with stress axis (Equation 2), psi
- B = Ordinate of point of intersection of slope line of plastic stress-strain curve with Young's modulus of elasticity line (Equation 3), psi
- c = Distance from the neutral axis to extreme fiber, in.
- E = Young's modulus of elasticity (slope of the stress-strain curve in elastic range), psi
- e = Strain, in./in.
- e_u = Ultimate strain (based on 2-in. gage length), in./in.
- F_{bu} = Ultimate bending modulus of rupture, psi
- F_{by} = Yield bending modulus, psi
- I = Moment of inertia of the entire cross-sectional area with respect to the neutral axis, in.^{4}
- k = Section factor (Equation 11)
- M = Bending moment, lb-in.
- m = Slope of stress-strain curve assumed in plastic range (Equation 1), psi
- Q = Static moment of the cross-sectional area between the neutral axis and extreme fiber about the neutral axis, in.^{3}
- s = Stress, psi
- s_{tu} = Ultimate tensile strength, psi
- s_{ty} = Yield tensile strength (0.2 per cent offset), psi

Ultimate Bending Modulus of Rupture: The slope m, intercept A and ordinate B shown in *Fig.* 2 can be determined graphically or by the use of the following equations (symbols are refined in the *Nomenclature*):

$$m = \frac{s_{tu} - s_{ty}}{e_u - \left(\frac{s_{ty}}{E} + 0.002\right)} \quad (1)$$

$$A = s_{tu} - e_u m \quad (2)$$

$$B = \frac{A}{1 - \frac{m}{E}} \quad (3)$$

A rectangular section of base b and height h that is subject to a symmetrical stress distribution in bending is shown in *Fig.* 3. The corresponding stress pattern is identical to the idealized stress-strain diagram of *Fig.* 2, except for the scale of strain, e, which is defined by

$$e = \frac{e_u y}{\frac{h}{2}} \quad (4)$$

For this section, the moment of resistance M_r is

$$M_r = 2\int_0^{h/2} (sby)\, dy \quad (5)$$

Combining Equation 4 and its differential with Equation 5 and simplifying gives:

$$M_r = \frac{bh^2}{2e_u^2}\int_0^{e_u} (se)\, de \quad (6)$$

The modulus of rupture $F_{bu} = M_r/Z$, where Z

Fig. 1—Bending stress diagram based on trapezoidal pattern of distribution

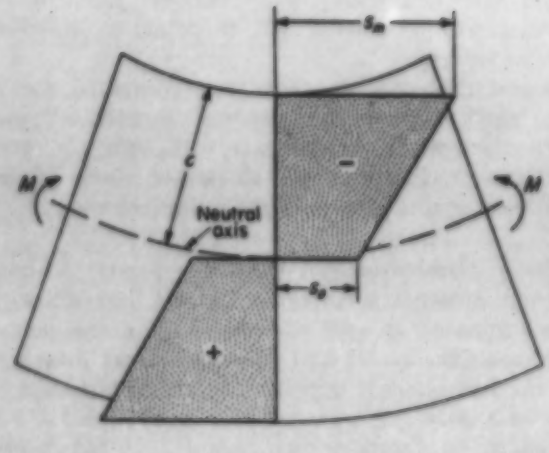
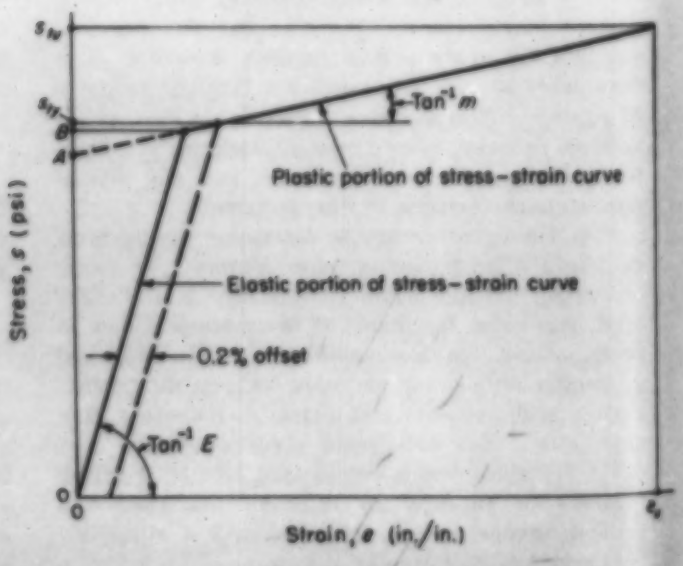


Fig. 2 — Idealized stress-strain diagram



is the section modulus I/c, or $bh^2/6$ for a rectangular section. From Equation 6, then

$$F_{bu} = \frac{3}{e_u^2} \int_0^{e_u} (se)\ de \quad \ldots\ldots (7)$$

If the material is assumed to be "rigid-ideally-plastic" ($E = \infty$ and $s_{ty} = s_{tu}$ so that the stress s is constant and equal to s_{tu}), Equation 7 reduces to to

$$F_{bu} = \frac{3\, s_{tu}}{2} \quad \ldots\ldots (8)$$

which provides an easily remembered value for a so-called "fully-plastic" ultimate modulus of rupture for a rectangular cross section when the effect of s_{ty} and E are not considered.

The integral expression

$$\int_0^{e_u} (se)\ de$$

represents the static moment of the area under the stress-strain diagram about the neutral axis. If this area, *Fig.* 3, is considered as being divided into three triangles, $(Os_{tu}e_u) + (OAs_{tu}) - (OAB)$,

Fig. 3—Rectangular section with symmetrical stress distribution pattern in bending

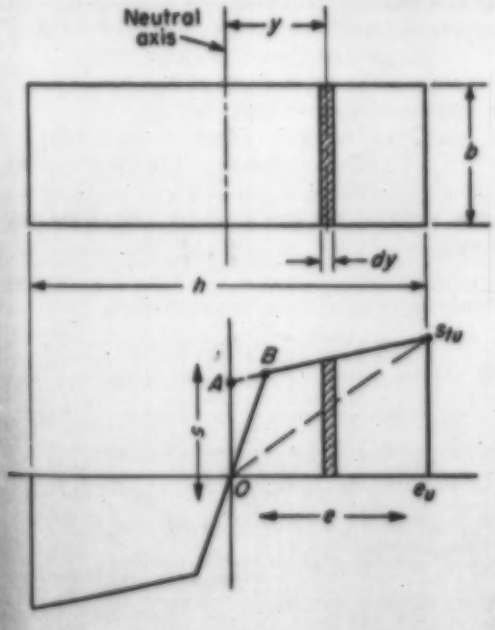


Fig. 4—Typical values of section factor, *k*

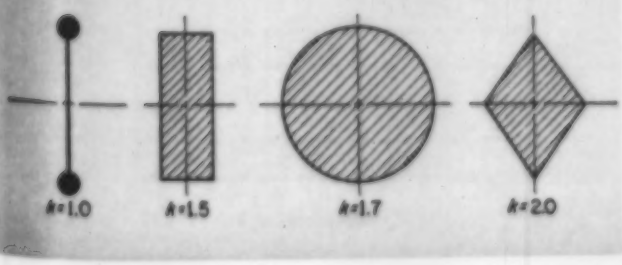


Fig. 5—Extrapolated curve plot of ultimate bending modulus of rupture versus section factor

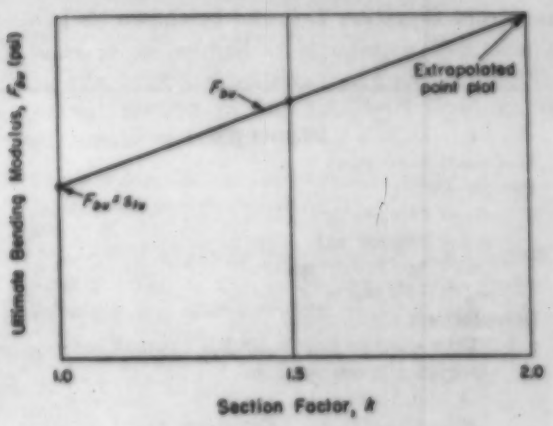


Fig. 6—Extrapolated curve plot of yield bending modulus versus section factor

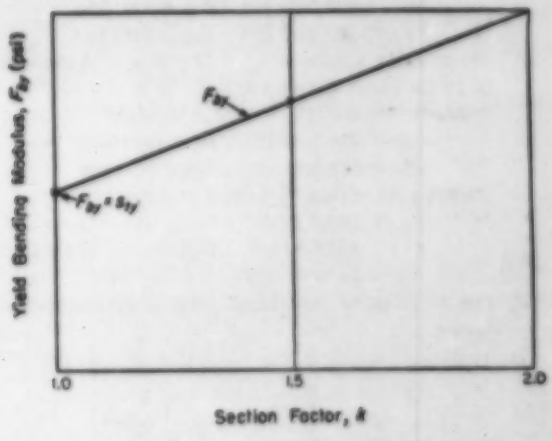
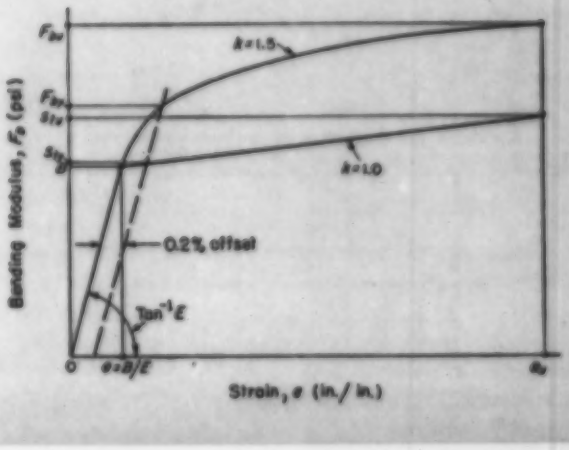


Fig. 7—Complete curve plot of bending modulus versus strain for a rectangular cross section



then the static moment about the neutral axis becomes

$$Q = \left[\left(\frac{s_{tu}\, e_u}{2}\right)\left(\frac{2\, e_u}{3}\right)\right] + \left[\left(\frac{A e_u}{2}\right)\left(\frac{e_u}{3}\right)\right] - \left[\left(\frac{\frac{AB}{E}}{2}\right)\left(\frac{\frac{B}{E}}{3}\right)\right]$$

and, from Equation 7, it can be shown that

$$F_{bu} = s_{tu} + \frac{A}{2}\left[1 - \left(\frac{B}{E e_u}\right)^2\right] \qquad (9)$$

Cozzone's method[3] furnishes for the bending modulus of rupture the expression

$$F_{bu} = s_{tu} + s_o\,(k - 1)$$

where s_o is the trapezoidal intercept. Comparing this expression with the equivalent Equation 9 given here, it will be found that

PROBLEM 1

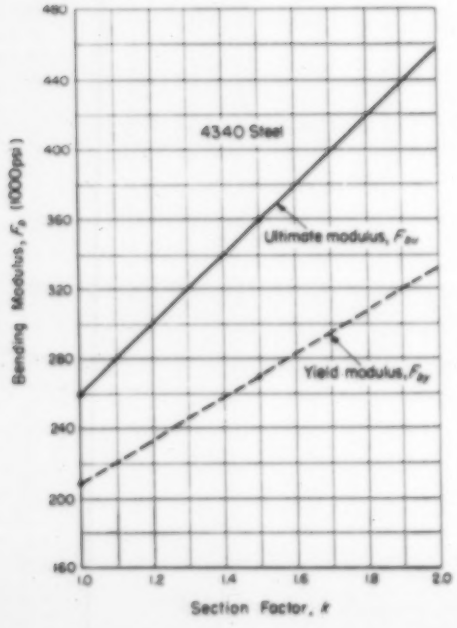
Material: 4340 steel

Design Data:

$s_{tu} = 260{,}000$ psi
$s_{ty} = 208{,}000$ psi
$E = 29{,}000{,}000$ psi
$e_u = 0.07$ in./in.

Calculations:

1. Ultimate bending modulus of rupture for rectangular cross section.
   $k = 1.5$ (*Fig.* 4)
   $m = 855{,}000$ psi (Equation 1)
   $A = 200{,}000$ psi (Equation 2)
   $B = 206{,}000$ psi (Equation 3)
   $F_{bu} = 359{,}000$ psi at $k = 1.5$ (Equation 10)
2. Yield bending modulus for rectangular cross section.
   Assume $e = (B/E) + 0.004 = 0.0111$ in./in.
   $s_t = 209{,}500$ psi (Equation 13)
   $F_b = 268{,}500$ psi (Equation 12)
   Permanent strain $= e - (F_b/E) = 0.0018$ in./in.; this value is too small.
   Assume $e = 0.0111 + 0.001 = 0.0121$
   $s_t = 210{,}300$ psi (Equation 13)
   $F_b = 275{,}800$ psi (Equation 12)
   Permanent strain $= 0.0026$ in./in.
   $F_{by} = 268{,}500 + [(20 - 18)/(26 - 18)]\,(275{,}800 - 268{,}500) = 270{,}000$ psi at $k = 1.5$
3. Curve plots of bending moduli versus section factor.



PROBLEM 2

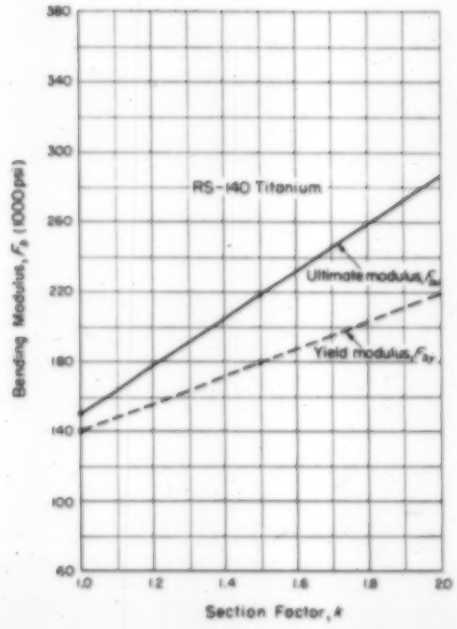
Material: RS-140 titanium

Design Data[4]**:**

$s_{tu} = 150{,}000$ psi
$s_{ty} = 140{,}000$ psi
$E = 16{,}000{,}000$ psi
$e_u = 0.08$ in./in.

Calculations:

1. Ultimate bending modulus of rupture for rectangular cross section.
   $k = 1.5$ (*Fig.* 4)
   $m = 144{,}400$ psi (Equation 1)
   $A = 138{,}500$ psi (Equation 2)
   $B = 139{,}800$ psi (Equation 3)
   $F_{bu} = 218{,}000$ psi at $k = 1.5$ (Equation 10)
2. Yield bending modulus for rectangular cross section.
   Assume $e = (B/E) + 0.004 = 0.0127$ in./in.
   $s_t = 140{,}300$ psi (Equation 13)
   $F_b = 176{,}800$ psi (Equation 12)
   Permanent strain $= e - (F_b/E) = 0.00165$ in./in.; this value is too small.
   Assume $e = 0.0127 + 0.001 = 0.0137$ in./in.
   $s_t = 140{,}500$ psi (Equation 13)
   $F_b = 181{,}600$ psi (Equation 12)
   Permanent strain $= 0.00237$ in./in.
   $F_{by} = 176{,}800 + [(200 - 165)/(237 - 165)]\,(181{,}600 - 176{,}800) = 179{,}100$ psi at $k = 1.5$.
3. Curve plots of bending modulus versus section factor.



$$s_o = A\left[1 - \left(\frac{B}{Ee_u}\right)^2\right]$$

and, consequently,

$$F_{bu} = s_{tu} + A\left[1 - \left(\frac{B}{Ee_u}\right)^2\right](k - 1) \quad \ldots\ldots (10)$$

The section factor k takes into account the shape of the cross-section. A few typical values of the section factor k, reproduced from Cozzone's paper[3], are shown in *Fig.* 4. The value of k is given by

$$k = \frac{2Q}{\frac{I}{c}} \quad \ldots\ldots (11)$$

A convenient method of expressing Equation 10 is to plot a curve of ultimate modulus of rupture, F_{bu}, versus section factor, k. The following procedure is recommended:

1. From Equation 10, calculate the values of F_{bu} for a rectangular cross-section at $k = 1.5$ and $k = 1.0$.
2. Plot the two points thus obtained and connect with a straight line, extending the line to the value of F_{bu} corresponding to $k = 2.0$.

The general form of this curve plot is shown in *Fig.* 5.

Yield Bending Modulus: The yield point in tension for "elastic" materials is defined as the stress at which permanent strain reaches a value of 0.002-inch per inch. Similarly, the yield modulus in bending in this analysis is defined as the nominal outer-fiber stress at which permanent strain reaches a value of 0.002-inch per inch in the outermost fiber. To find the yield bending modulus, the following procedure is used.

1. Rewrite Equation 9 for a rectangular cross section eliminating subscript u. Thus

$$F_b = s_t + \frac{A}{2}\left[1 - \left(\frac{B}{Ee}\right)^2\right] \quad \ldots\ldots (12)$$

This expression is valid for values of $e \geqq B/E$.

2. Assume $e = (B/E) + 0.004$ at the extreme fiber.

3. Calculate s_t for $e = (B/E) + 0.004$ from:

$$s_t = A + em \quad \ldots\ldots (13)$$

4. Calculate F_b for $e = (B/E) + 0.004$ from Equation 12.

5. Divide the value of F_b obtained from Step 4 by E and subtract the quotient from the value of e used in Step 2 to determine the permanent strain at the extreme fiber.

6. If the answer obtained in Step 5 is less than 0.002-in./in., increase e by 0.001-in./in. and repeat Steps 2 through 5 to get an answer larger than 0.002-in./in. If the answer obtained in Step 5 is more than 0.002-in./in., decrease e by 0.001-in./in. and repeat Steps 2 through 5 to get an answer less than 0.002-in./in.

7. Determine the value of F_{by} at $k = 1.5$ by straight-line interpolation between the two values of e to find the stress where the permanent strain is 0.002-in./in.

The yield bending modulus for other values of k can be obtained by a plot similar to the one recommended for ultimate modulus. Connect the plotted values of F_{by} at $k = 1.5$ found from Step 7

PROBLEM 3

Material: 7075-T6 aluminum hand forging

Design Data[1, 2]:

$s_{tu} = 69{,}000$ psi
$s_{ty} = 58{,}000$ psi
$E = 10{,}400{,}000$ psi
$e_u = 0.03$ in./in.

Calculations:

1. Ultimate bending modulus of rupture for rectangular cross section.
   $k = 1.5$ (*Fig.* 4)
   $m = 491{,}000$ psi (Equation 1)
   $A = 54{,}300$ psi (Equation 2)
   $B = 57{,}000$ psi (Equation 3)
   $F_{bu} = 95{,}200$ psi at $k = 1.5$ (Equation 10)
2. Yield bending modulus for rectangular cross section.
   Assume $e = (B/E) + 0.004 = 0.0095$ in./in.
   $s_t = 59{,}000$ psi (Equation 13)
   $F_b = 77{,}100$ psi (Equation 12)
   Permanent strain $= e - (F_b/E) = 0.0021$ in./in.
   Assume $e = 0.0095 - 0.001 = 0.0085$ in./in.
   $s_t = 58{,}500$ psi (Equation 13)
   $F_b = 74{,}400$ psi (Equation 12)
   Permanent strain $= 0.00135$ in./in.
   $F_{by} = 74{,}400 + [(200 - 135)/(210 - 135)]\ (77{,}100 - 74{,}400) = 76{,}700$ psi at $k = 1.5$
3. Curve plots of bending modulus versus section factor.

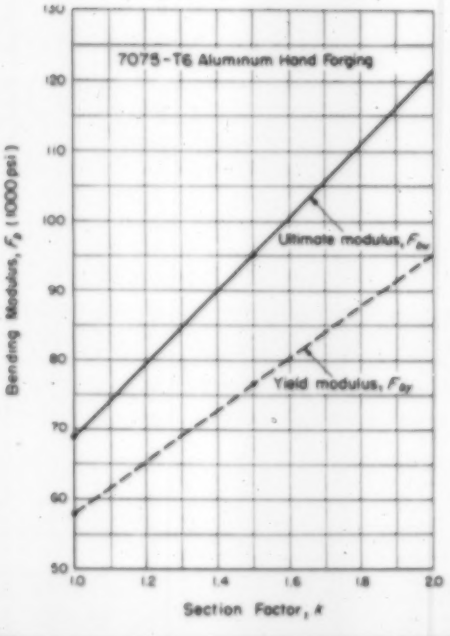


Table 1—Comparison of Calculation Methods

Method	F_{by} (psi)			F_{bu} (psi)		
	$k = 1.0$	$k = 1.5$	$k = 2.0$	$k = 1.0$	$k = 1.5$	$k = 2.0$
150,000 psi Steel*						
Simplified Method	135,000	181,000	227,000	150,000	217,000	284,000
Cozzone Method	135,000	167,000	199,000	150,000	222,000	294,000
2014-T Aluminum†						
Simplified Method	50,000	66,900	83,800	65,000	89,400	113,800
Cozzone Method	50,000	61,500	73,000	65,000	95,000	125,000

*$E = 29 \times 10^6$ psi, $s_{tu} = 150{,}000$ psi, $s_{ty} = 135{,}000$ psi, $e_u = 0.145$ in./in.
†$E = 10.6 \times 10^6$ psi, $s_{tu} = 65{,}000$ psi, $s_{ty} = 50{,}000$ psi, $e_u = 0.10$ in./in.

and $F_{by} = s_{ty}$ ($k = 1.0$) by straight line and extrapolate the line to find F_{by} at $k = 2.0$. The general form of the yield modulus versus section factor curve is shown in *Fig.* 6.

A complete curve of bending moduli, F_b, versus strain, e, for a rectangular cross section can be constructed by solving Equation 12 for $e = B/E$, $e = (B/E) + 0.001$, $e = (B/E) + 0.002$, etc., up to e_u. *Fig.* 7 shows such a curve. The value of F_{by} at $k = 1.5$ can be found graphically in the same manner as the yield point in tension is found from a stress-strain diagram of a standard tensile test.

Sample Calculations: Application of this method is illustrated in the three accompanying problem examples for (1) a 260,000-psi ultimate-strength steel, (2) a 150,000-psi ultimate-strength titanium and (3) a 7075-T6 aluminum hand forging.

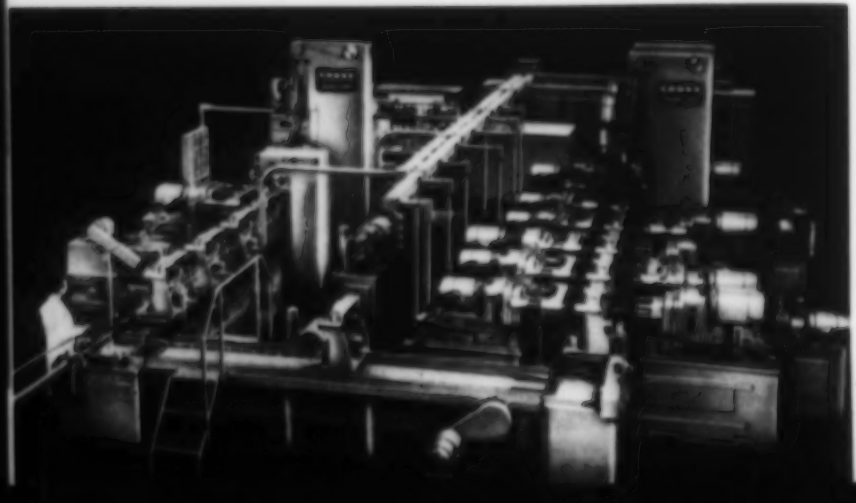
A comparison of results obtained with the simplified method given here and Cozzone's method is given in *Table* 1. A 150,000-psi ultimate- strength steel forging and a 2014-T aluminum-alloy forging were used as the basis for calculation of the comparative data.

REFERENCES

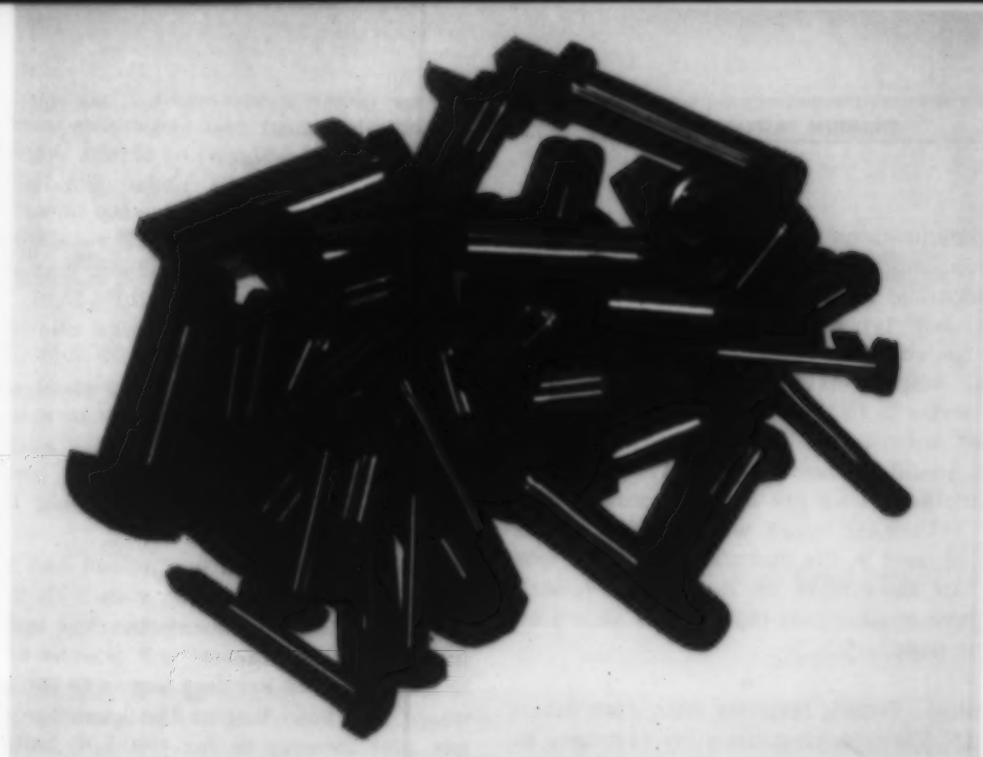
1. "Strength of Aircraft Elements," *ANC*-5, June, 1951, Table 3.111 (j), Page 54.
2. "Aluminum Alloy Forgings, Heat-Treated," *Federal Specification QQ-A-367c*, July 12, 1943, Table IV, Page 5.
3. F. P. Cozzone—"Bending Strength in the Plastic Range," *Journal of the Aeronautical Sciences*, Vol. 10, May, 1943, Pages 137-151.
4. "Republic Titanium and Titanium Alloys," Republic Steel Corp., 1954, Page 26.

Contemporary Design

Machine Tool Performs 139 Operations



DESIGNED to machine flywheel housings completely, except for grinding three faces, a new special machine tool performs 139 operations on 170 pieces per hour. The operations include drilling, tapping, chamfering, reaming, counterboring and inspection. Both standard and automatic-transmission flywheel housings may be machined because the proper tooling setup can be automatically selected at each work station. Because parts being machined are irregular in shape, special palletized work fixtures are used. Parts are clamped to the fixtures by hydraulic wrenches. Manufacturer is the Cross Co.



A Progress Report on

Titanium Fasteners

By John Van Hamersveld
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DEVELOPMENT of titanium into a usable production material has been a challenge to both metallurgical and processing know-how. However, tremendous progress has been made in the relatively short span of five years, as compared to the 50-year development of aluminum, the 30-year development of magnesium, and the centuries that lie behind the present-day steel.

One aspect of this development that has received increasing attention is the great weight-saving potentialities of titanium as a fastener material. Northrop Aircraft Inc. is now engaged in an extensive testing program of titanium-alloy fasteners and parts to provide data for design evaluation. The following discussion highlights some of the significant results and conclusions that have been obtained from the program to date.

Basic Design Concept: When the titanium-alloy material reached a form of stabilization, a comprehensive design study was made of one of Northrop's aircraft models. It was found that a total of 1243 pounds of steel fasteners and fittings were used. Direct substitution of titanium for these specific items would provide a weight saving of approximately 500 pounds per plane. This approach offered one of the simplest methods of saving this amount of weight, with a minimum of design change through a direct substitution.

Based on this study, therefore, a basic design concept is that the saving of weight can be most readily achieved by directly substituting titanium-alloy fasteners for steel on a size-for-size basis and in the fastener configurations which represent the greatest potential usage. Some of the reasons supporting this concept are:

1. Direct substitution of titanium for steel eliminates supply and procurement problems in the assembly line as well as "in the field" by allowing two-way interchangeability.

2. Two-way interchangeability permits fastener producers to utilize their manufacturing know-how in modifying present equipment and processes to produce good titanium fasteners.

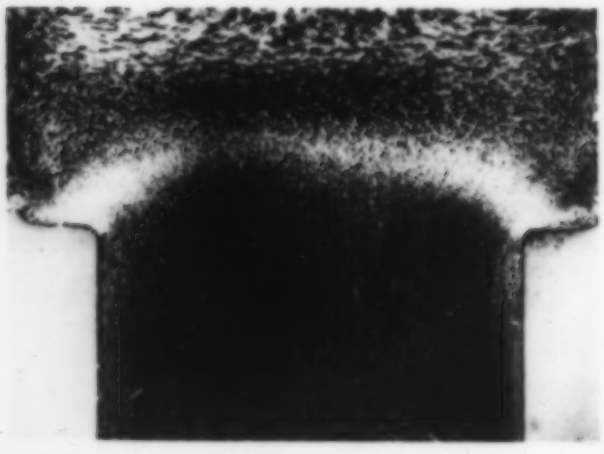
3. Two-way interchangeability drastically decreases the time required to effect weight saving by permitting the immediate use of fasteners as they become available. The amount of time which it would take to design, manufacture, and prepare procurement specifications and standards for non-

standard configurations is also saved.

The current Northrop program constitutes the testing of identical fasteners of titanium and alloy steel. Fastener types AN3 through AN8 and AN509 are the configurations selected on the basis of potential weight saving. The object of this initial test series is to determine the feasibility of the proposed substitution, and at the same time, to establish qualified sources of supply. The four per cent aluminum, four per cent manganese titanium alloy (C-130AM type) was selected as the material to be used in the manufacture of the new fasteners. An assortment of $\frac{3}{16}$, $\frac{1}{4}$ and $\frac{3}{8}$-inch diameter titanium-alloy test fasteners is shown on the preceding page.

Test Results: Tensile behavior data were determined for AN-509 type titanium-alloy fasteners in 7075-T6 (75S-T6) aluminum-alloy sheet. This particular aluminum alloy was employed because it represents the greatest usage on current aircraft. Results indicate that the average failure strength of metallurgically sound titanium fasteners is approximately 10 per cent greater than for steel (heat treated to the 125,000 to 145,000 psi range) in the same size and configuration. The causes of all titanium bolt failures which occurred below the specified minimum for steel were traced to faulty fastener material. Light weight Esna "Blue Jay" nuts were found to be strong enough to develop ultimate fastener tensile strengths.

Where the bolt shank was subject to static double shear failure conditions, it was found that failure, after its onset, occurred rapidly in the titanium-alloy bolts. The average static ultimate tensile and double shear strengths of the titanium-alloy fasteners ranged from equal to, in the $\frac{3}{16}$-inch diameter, up to 18 per cent above their steel counterparts in the $\frac{1}{2}$-inch diameter configurations.



Effect of hot heading operation on grain size of titanium alloy bolt. Smaller grain sizes can be obtained by more rigidly controlled heating cycles and, possibly, by heat treatment

Single-lap shear test assemblies used in the test program were designed to obtain behavior data on bolt-nut combinations under simulated airframe load conditions. The single-lap shear test results indicate that (1) for AN364 nuts, approximately equal strength values can be obtained on both steel and titanium; (2) for light-weight H10 series "Kaynar" steel nuts, the design allowables can be met on both titanium and steel; and (3) for Esna "NTED" series aluminum-alloy shear nuts, the design allowables for steel can not be met with either steel or titanium bolts. Because such joints become "yield critical," it has been concluded that steel design shear allowables cannot be met with aluminum-alloy shear nuts.

To obtain comparative preload and torque data, AN365 steel nuts were used on both the titanium-alloy and steel test fasteners. The test results indicate that the titanium bolt preload due to torque is from 10 to 50 per cent less than the preload produced in a steel bolt at the same torque. The 10 per cent average is for titanium bolts with burnished threads while the 50 per cent average is for those with unburnished threads. No antigalling treatment was applied to these fasteners before testing. It is anticipated, therefore, that a greater torque will be necessary for untreated titanium bolt and AN365 nut combinations.

Tension-tension fatigue tests are being conducted at five stress levels on each diameter of bolt being tested. These test results are being used to establish S-N curves which will become a part of design criteria. Initial results indicated that the endurance limit for titanium alloy fasteners fell below that of steel at approximately 25 per cent of ultimate tensile strength levels. However, recently received titanium bolts, which were produced by improved manufacturing methods and heat treated to the 160,000 to 180,000 psi strength level, were superior to their steel counterparts at all stress levels tested. At some stress levels the titanium test fasteners withstood from ten to twenty times the number of cycles required to break their steel counterparts and were finally removed without any sign of failure.

Results obtained from corrosion testing of titanium fasteners coupled to dissimilar aircraft structural materials, such as magnesium and aluminum alloys, indicate that the galvanic behavior of titanium is similar to that of the 18-8 stabilized steels in the anodic end of the series.

Test Synopsis: Analysis of the test program in its present state of progress establishes three significant facts:

1. Direct substitution of titanium-alloy fasteners for steel on a size-for-size basis, in the configurations tested, appears to be feasible.

2. Qualified sources of supply for titanium-alloy production fasteners have been established.

3. Rigid quality control and inspection procedures will be a requirement until such time as consistently high-quality titanium-alloy fastener stock becomes available to manufacturers of fasteners.

Epicyclic Gear Systems

A simplified method for design and selection of an epicyclic or planetary gear system where a choice of systems is possible

By Robert N. Abild
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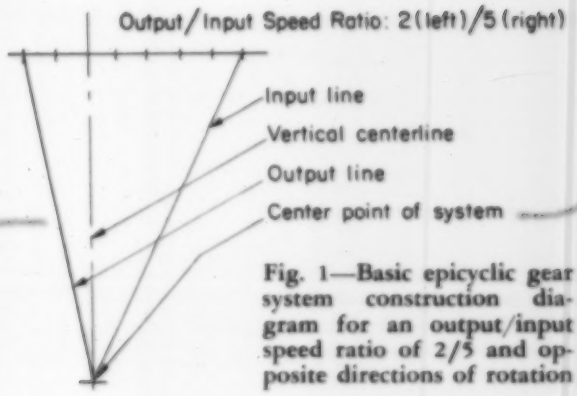


Fig. 1—Basic epicyclic gear system construction diagram for an output/input speed ratio of 2/5 and opposite directions of rotation

IN THE design of an epicyclic—or planetary—gear system, the designer usually must resort to trial and error methods to establish a basic configuration which will satisfy the design requirements. It is desirable although not always easy to discover as many as two different systems from which to choose. Actually, the number of combinations from which a choice can be made is large.

In the method discussed here the design requirements for relative speeds of the input and output members and their directions of rotation are first indicated in a simple diagram, *Fig.* 1. This automatically insures that any arrangement considered will satisfy the requirements with an accompanying saving of time and effort. Next, two diagrams like the one shown in *Fig.* 1 are used as guides for drawing schematics of four corresponding basic gear systems, *Fig.* 2. The last step is to select the most desirable configuration and refine its proportions if desired. It will be assumed all systems have dual pinions, at first. Then it will be shown that in some circumstances these dual-pinion systems can be simplified to single-pinion types.

Dual-Pinion Systems: To construct the diagram in *Fig.* 1, draw a vertical centerline with a horizontal line across the upper end, and mark a point lower down on the centerline to represent the center of the gear system. Indicate the design requirements by marking off on the horizontal line distances from the centerline which are proportional to the speeds of the input and output members. Actual distances do not matter as only their ratio to each other is important. Distances to the right side of center represent rotation to the right, and distances to the left represent rotation to the left. In *Fig.* 1, the output speed is assumed to be 2 and the input speed is 5 with the output turning to the left and the input turning to the right. Thus the output-input speed ratio is 2/5. In this case mark a distance of 2 units to the left of the centerline and a distance of 5 units to the right. These marks are then connected to the center point by straight lines and become the output and input lines as indicated in *Fig.* 1. Draw two such diagrams, so far identical, one above the other on the left side of a sheet of paper, *Fig.* 2. Next, draw a line slanting upward to the right on the upper diagram in *Fig.* 2 and upward to the left on the lower one at an angle of approximately 45 degrees. This slant line determines pinion radii.

The next step is to draw corresponding schematics of the indicated gear systems, as shown in *Fig.* 2. The center of the pinion in the schematics can be placed in either of two positions: (1) where the slant line crosses the input line or (2) where it crosses the output line. If the pinion center is placed at the point where the slant line of the vector diagram crosses the vertical centerline, this will establish the arm as the fixed member of the system. This solution will be a perfectly practical gear system, and may even be especially desirable. However, it will not be an epicyclic system, because

the pinion center is fixed. To explore such systems an extra schematic will be required for each simplified vector diagram.

In the schematics in *Fig.* 2 one pitch circle of the pinion is drawn tangent to the projection line from the point where the slant line of the vector diagram crosses the vertical centerline, and meshes there with another pitch circle drawn from the projection line of the center point of the system. This latter pitch circle always represents the fixed gear of the system. The second pitch circle of the pinion is tangent to the projection line from the point where the slant line of the vector diagram crosses either the input or output line; this second pinion pitch circle meshes with a second pitch circle drawn about the center point of the system.

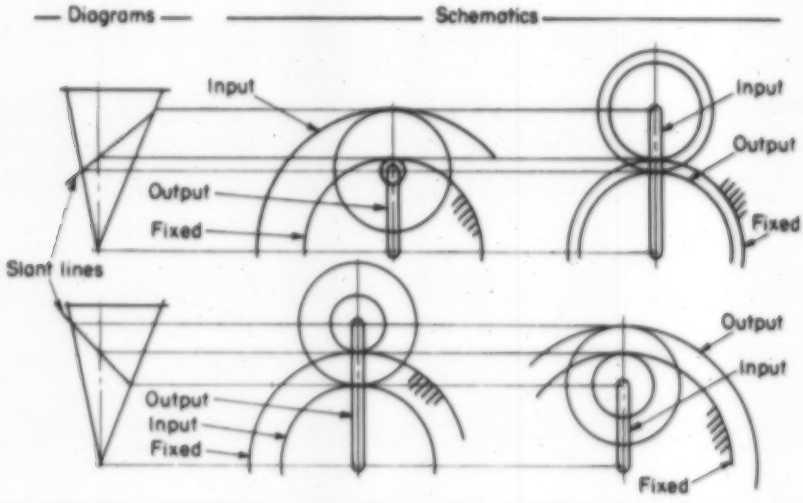


Fig. 2—Four of many possible epicyclic gear system schematics based on requirements in *Fig.* 1. Changes in slope and position of slant line vary pinion and gear proportions

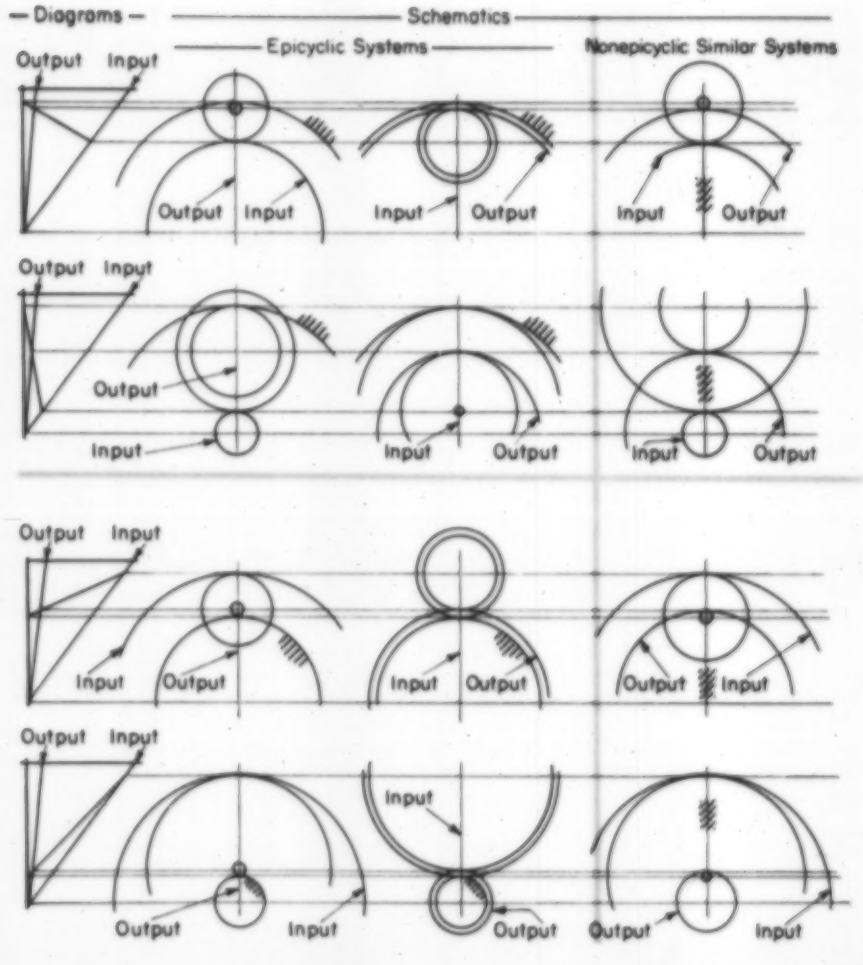


Fig. 3—Schematics of epicyclic and nonepicyclic gear systems for an output/input speed ratio of 1/10 and same direction of rotation. Input and output lines are placed on same side of centerline. Some systems shown are impractical and would be eliminated

A representation of the pinion carrier which supports the pinion axis should be drawn as depicted in *Fig.* 2. Completion of both schematics for the two diagrams produces the four basic configurations which will satisfy the requirements.

Now the schematics should be studied to see if one of them is suitable for the intended use without further changes. The circles drawn represent the pitch circles of the gears and can be measured directly if the construction has been carefully done. Of course the dimensions can be calculated from the diagram by employing trigonometry using the assumed angle of the slanted line. If the measured size of system is too small or too large, it can be changed by redrawing the schematics and repositioning the slant line at the same angle but higher or lower on the centerline as necessary. The type of load to be carried may require the use of several pinions, but the pinions cannot be so large as to interfere with each other.

The relative sizes of gears to each other can be changed without affecting design requirements by changing the angle of the slant line in the diagrams and making the schematics correspond. As this slant line becomes more nearly horizontal the pinion diameters become relatively smaller, but both pinion diameters do not get smaller at the same rate. In any particular design the effect of changes in the slant angle can be ascertained by drawing the diagram and its schematics for both extremes of slant angle. Such a study for both diagrams is made in *Fig.* 3. In doing this it becomes obvious that in some schemes one pinion diameter will always be too small, and such approaches should be eliminated.

Single Pinion Design: The previously discussed pinions have two separate pitch circles and sets of teeth rigidly attached to each other. In systems which have their output turning in the same direction as the input it is possible to find a position of the slant line such that only a single pinion diameter is required. This slant position should be located so that

$$R_m = R_f/(\rho - 1)$$

where R_m = radius of the moving, system-centered gear, R_f = radius of the fixed gear, and ρ = the output-input speed ratio.

Velocity Vectors: The diagrams drawn are actually skeletons of velocity vector diagrams. Although it is not necessary for a gear design solution, the designer may wish to complete a vector diagram in order to better understand the basis for this design procedure. As shown in *Fig.* 4 this velocity vector diagram can be drawn to correspond to any one schematic and is started in the usual manner. Then a vector is drawn horizontally from the centerline at each point where one of the pitch circles of the schematic crosses the vertical centerline plus one for the pinion center. The vectors start at the centerline and the arrow point is made at the intersection with the slanted line. The input and output members are represented on the vector diagrams by the part of the input and output lines up to the point where they meet a vector. The slanted line is the terminus of all vectors dealing with the pinion. This line can be extended to

Fig. 4—Gear velocity vector diagram construction for an epicyclic system

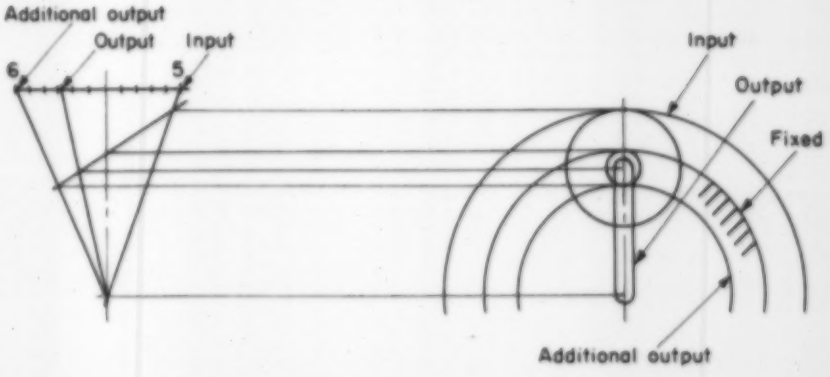


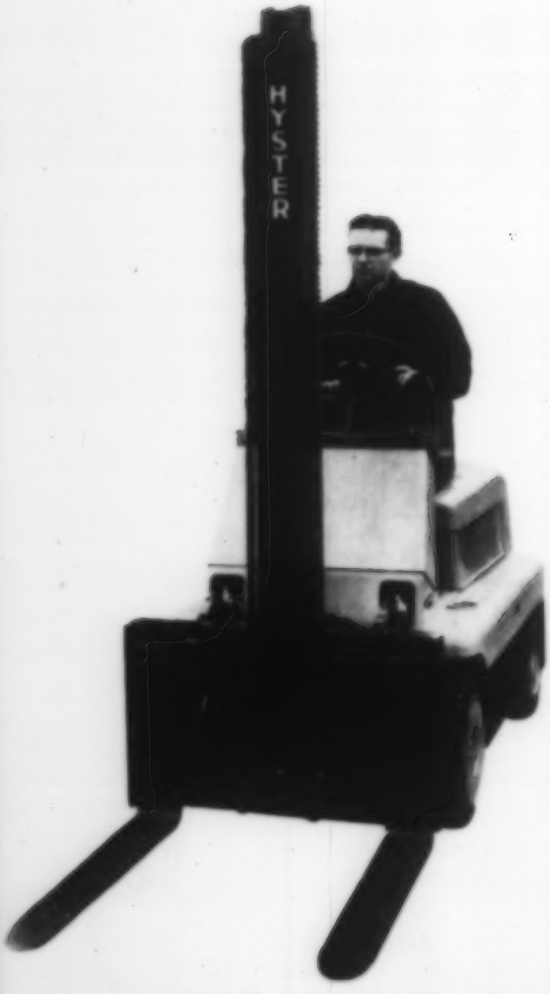
Fig. 5 — Basic construction diagram and schematic for epicyclic system with two outputs. Output/input speed ratio for additional output is 6 (left)/5 (right)

permit the construction of all the vectors for the pinion. Where the slanted line crosses the vertical centerline is a point of zero velocity and represents the point where the pinion meshes with the fixed gear of the system.

Multiple-Output Systems: It is possible to design an epicyclic system having more than one output. To design a system for this condition the simplified vector diagram is drawn in the same way except the additional distance from the centerline for this added requirement is marked off on the horizontal construction line and joined to the center point of the system, *Fig.* 5. When the slant line is drawn, it must pass through this line. Three schematics are required for such a system, and the pinion center should be placed where the slant line of the vector diagram crosses the input line or either output line. It will be found that three pitch diameters will be required on the pinion. In some cases two of these diameters can be replaced by one pitch diameter by use of the formula discussed previously. Also, it is possible by use of this method to design a system having two inputs and an output but no fixed gear.

After the configuration is chosen, the last step is to check the possibility of making gears with integral numbers of teeth to correspond with the pitch circles drawn. Minor changes in the angle of the slant line can be made to accomplish this. Only gears which mesh with each other need to be of the same pitch and pressure angle. For greater precision the triangles of the vector diagram can be calculated by using trigonometry.

Contemporary Design



Lift Truck Has Improved Visibility

IMPROVED visibility is only one of the advantages claimed for a newly introduced Hyster lift truck using a single lifting mast. Other advantages, which are a direct result of reduced obstruction of the operator's vision, are faster operating speeds, more accurate load placing, safer load handling and reduced driver fatigue. Total weight of the single, telescoping box-section mast is said to be equal to a standard assembly. However, torsional rigidity has been increased 80 per cent and mast deflection reduced by 50 per cent. Hoisting speed has been increased by 15 per cent.

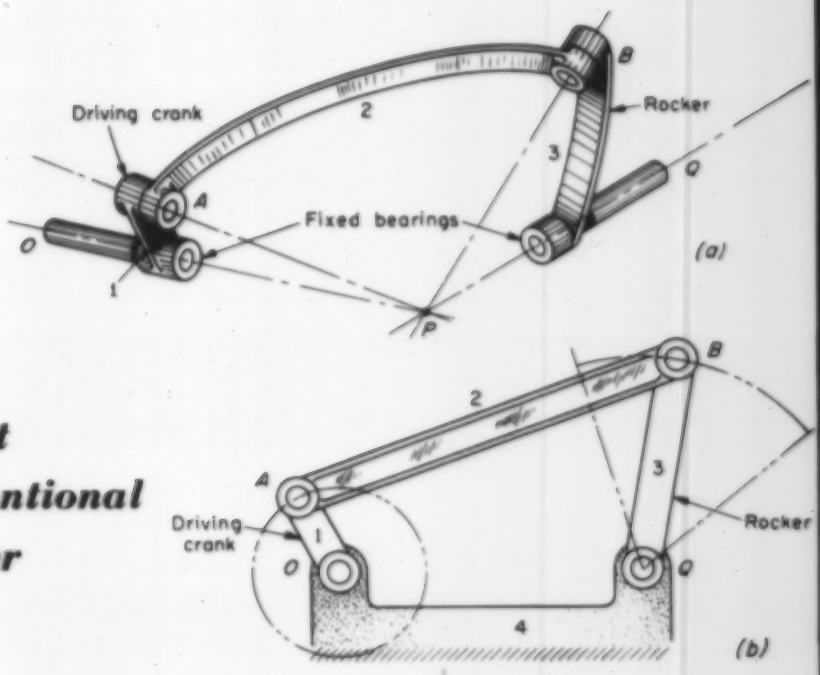


Fig. 1—Two versions of simple crank-and-rocker mechanism showing, *a*, conic form and, *b*, plane form. Axes of pin joints are parallel in the plane form but intersect at a common point *P* in the conic design

Conic linkages use pivot characteristics of conventional plane linkages and offer design possibilities for

3-D Mechanisms

By F. R. Erskine Crossley
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Yale University
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OF THE many different types of linkages used in design, the group identified by the general classification "quadric chain" is one of the most common. The well-known slider-crank and simple four-bar linkage, for example, are typical "plane" forms of the quadric chain in which motions of the operating elements are confined to two dimensions. Less known, but also of importance, are the various conic quadric linkages which are essentially three-dimensional counterparts of the plane forms. A familiar mechanism of this type that has been widely used is the standard universal joint; however, many other three-dimensional linkage variations are also possible.

Basic types and characteristics of the conic quadric linkages will be discussed in this article. A method of velocity analysis for these mechanisms will be considered later in a second article.

In the design of conic quadric chains, as contrasted to other three-dimensional linkages, link connections do not require the use of ball-and-socket joints. As will be shown in the discussion to follow, only plain cylindrical pin joints are necessary.

Basic Design Characteristics: The conic quadric chain is distinguished from the general run of three-dimensional linkages by the feature that its axes intersect and meet in a point, as in the case of the axes and lines of tooth contact for bevel gears. This construction is the reason for the name "conic."

Conic and plane forms of the common crank-and-rocker mechanism are shown in *Fig.* 1. In the conic design, *Fig.* 1*a*, the axis of the crankpin *A* (driving crank), as it rotates about the axis *OP*,

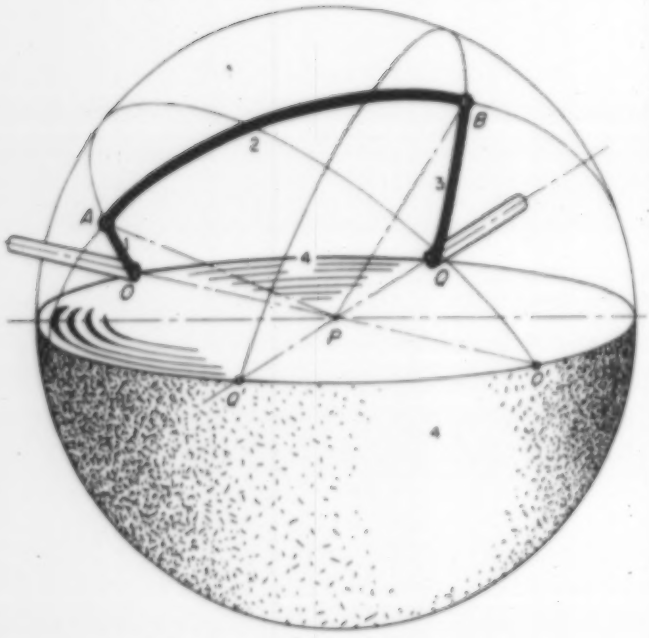


Fig. 2—Above—Simple conic quadric linkage showing principles of spherical construction. Axes of the pin joints meet at the center of the sphere and all motion takes place along the spherical surface

Fig. 3—Below—Modified conic linkage design with extended pin connections to prevent interference of links during rotation

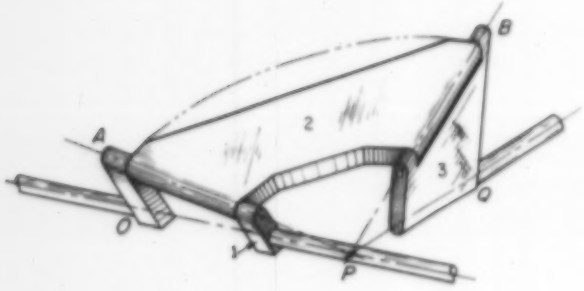
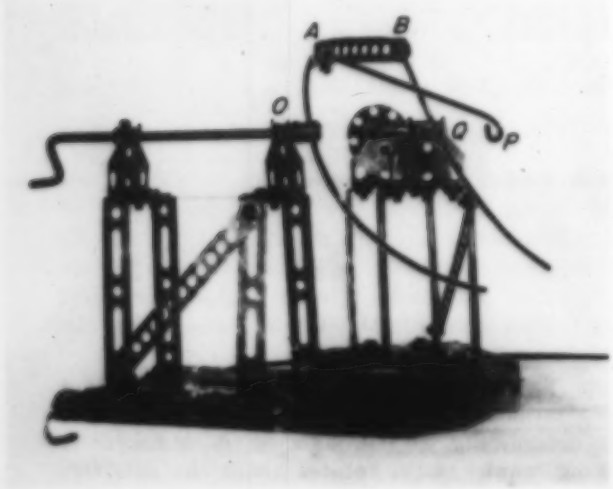


Fig. 4—Model of conic double rocker in which both cranks can only oscillate



describes a cone with *P* as apex. The driven rocker, link 3, will oscillate back and forth, describing another conical surface about the axis *QP*. If the slant heights of these two cones are made to agree, *A* and *B* are then equidistant from *P* and will remain so throughout their motion. The complete motion can thus be described on the surface of a sphere whose center is *P*, *Fig.* 2.

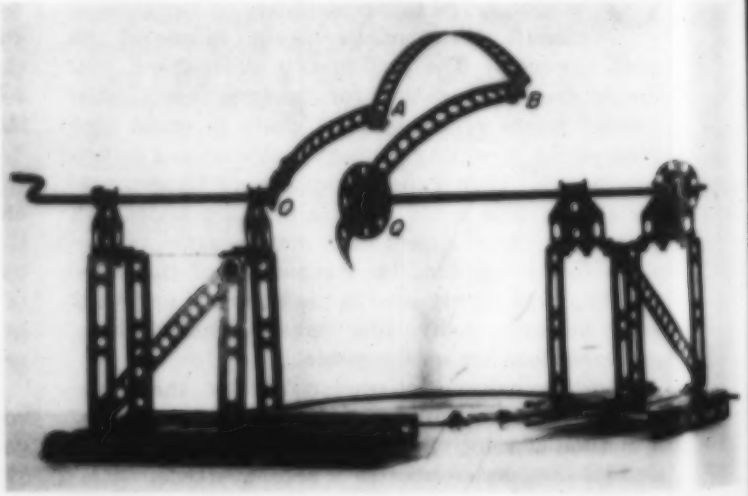
The line *AB*, or link 2, is always on the surface of this sphere. Since it has a fixed length, it always subtends a constant angle at the center. This angle is the same as that between the axes of the pin joints at *A* and *B*, offering proof that ball-and-socket connections are not needed.

A possible design problem with this mechanism may arise if the pin joints are short as shown in *Fig.* 1*a* and the angle between the driven and driving shafts is large. Under these conditions, when a force is transmitted through pin *A* by the driving crank, its direction at *A* will be tangential, tending to make *B* move parallel to *A* or into or out of, instead of around, the sphere. As a result, the driven rocker, link 3, may be subjected to bending loads during operation.

Two methods are available to avoid this force action. First, the link *AB* may actually be anchored to the center of the sphere by extending either shaft *O* or *Q* to *P*. However, this construction would require the use of a ball-and-socket joint at *P*. In the second method, the lengths of the pins at *A* and *B* are increased, as shown in *Fig.* 3. Here, the three links, 1, 2 and 3, appear more as the base part of the three plane triangles (or circle sectors), *OAP*, *ABP* and *BQP*. Link 1 becomes an inclined crankshaft to facilitate rotation without interference with link 2. Links 2 and 3 are hinged together.

Linkage Variations: The number of construction and motion variations possible with the conic quadric design parallel those of the conventional (plane) four-bar linkage, if various combinations of turning and sliding joints, or kinematic pairs,

Fig. 5—Model of conic drag-link mechanism for producing quick-return motions



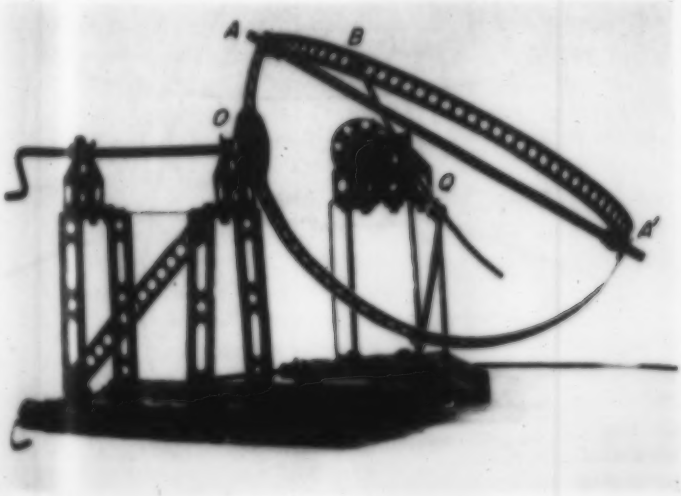
are used. A classification scheme presented by Reuleaux for both the plane and conic forms shows 54 different mechanism types, 24 being conic.

Among these designs, two are of particular interest. One is the double rocker-arm type, *Fig.* 4, in which both cranks, *OA* and *QB*, can only oscillate. The other is the drag-link type, *Fig.* 5, which is useful in producing quick-return motions. With the latter arrangement, if *OA* is rotating at uniform speed, crank *QB* will be driven at a varying angular velocity, alternately fast and slow, during each revolution.

The models shown in *Figs.* 4 and 5 were constructed from "Erector" parts and clothes hanger wire, and are adjustable. Models such as these are useful design aids in three-dimensional analysis since it is usually difficult to visualize the motions that occur or to predict dead-center conditions. In *Fig.* 4, the purpose of the radial wire *AP* is to identify the geometrical center of the base sphere. In *Fig.* 5, the shaft of the driven member is extended through the center of the sphere to avoid interference between the cranks.

Link Construction: Theoretically, all links of any given mechanism will have the same curvature; their radius will be the same as the base sphere. In practice, however, joints must be arranged with links side by side, so that the true basis of the mechanisms may be regarded as a series of concentric spherical shells, with neighboring links becoming elements of the surface of neighboring shells. Actually, in many cases it is difficult to recognize the base sphere at all, as for instance in the linkage shown in *Fig.* 3. The only essential feature of design theory that must be preserved in all designs is the previously discussed angular relationship between the joints of each of the four links. In the model in *Fig.* 6, the spherical nature of the links is emphasized. This mechanism is fundamentally the same as the one shown in *Fig.* 4, and produces exactly the same motion. If the third link, *QB*, rather than the second, had been made

Fig. 6—Model of conic double rocker with links extended to emphasize spherical construction



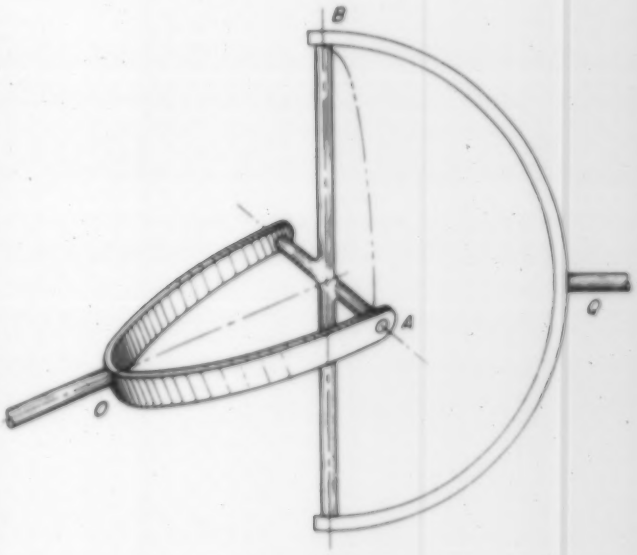


Fig. 7—Construction of universal joint, or Hooke's coupling, based on conic linkage principles. Each of the three moving links is a 90-degree member

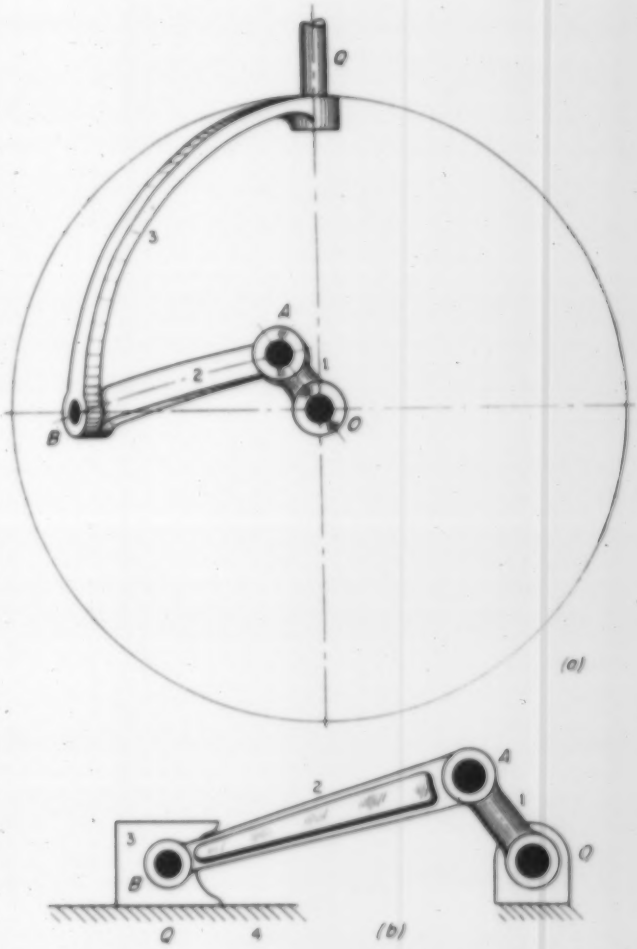


Fig. 8—Two variations of slider-crank showing, *a*, conic design and, *b*, plane form. Conic construction is based on one moving and one fixed 90-degree link

into the D-shape of a semicircle with its diameter, then the middle link *AB* would take the form of an *X* and there would appear a mechanism similar to the common universal joint. In the universal joint, *Fig.* 7, the three moving links are all right angled.

Preferably, links are specified by the angle that they subtend, since the size of the theoretical base sphere has no effect upon the motion of the mechanism. Links that subtend an angle of 90 degrees have a special significance. At the same time, no link need subtend an angle of more than 90 degrees. If two axes do intersect at an obtuse angle, extension of one axis across the base sphere will also form an acute angle that is a supplement of the obtuse angle. Thus, two axes that intersect at 123 degrees will also form a 57-degree angle with each other when one axis is extended. Thus, in *Fig.* 6 the linkage *OABQ* is the same as the linkage *OA'BQ* which merely has two obtuse, instead of acute, subtended angles.

Application Possibilities: In *Fig.* 8*a*, the driven link 3 subtends an angle of 90 degrees. If the point *Q* is the pole of the sphere, point *B* will traverse a great-circle path along the "equator." Under these conditions, it is apparent that when the angle between the fixed axes *O* and *Q* is also a right angle, as shown, the conic counterpart of the familiar slider-crank mechanism, *Fig.* 8*b*, is produced.

This similarity of mechanisms does not hold, however, if both *O* and *B* in *Fig.* 8*a* are raised, so that the path of *B* lies on a small circle of the sphere, corresponding to a parallel of latitude, with *O* at the same latitude. Undoubtedly, link 3 could be replaced by a slider moving along the small circle path, but the motion of *B* would not be symmetrical with respect to the angle *AOB*. For example, the extreme position of travel for *B*, nearest to *O*, would not occur when points *O*, *A* and *B* all lie on the same small circle of latitude because links 1 and 2 are elements of great circles. The motion of point *B* will bear close resemblance to that of the two-dimensional slider-crank mechanism only when link 3 and fixed link 4 both subtend angles of 90 degrees.

If, for the design shown in *Fig.* 8*a*, it is assumed that link 2 is also made to subtend a 90-degree angle, movement at *B* will occur only when there is a horizontal (east-west) displacement of point *A*. North or south movement of *A* will merely turn link 2 without moving *B*. This characteristic corresponds to the operation of the plane Scotch yoke mechanism. Thus, the conic counterpart just described might well appear as shown in *Fig.* 9, where the 90-degree link 2 has been converted to

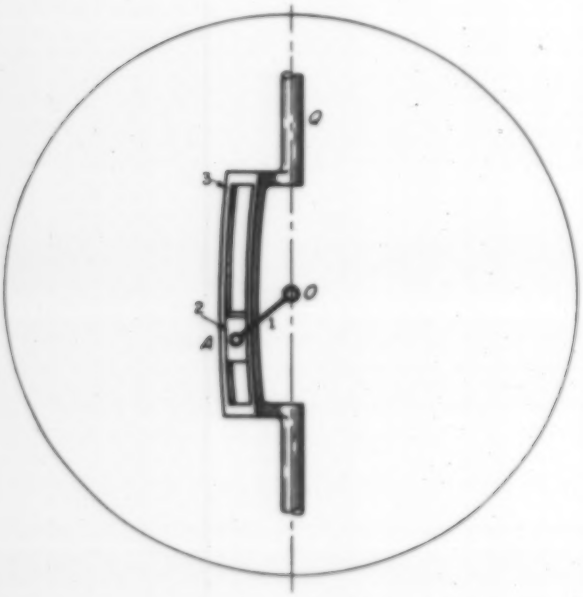


Fig. 9—Above—Conic counterpart of Scotch yoke mechanism. This design is an inversion of the universal joint shown in *Fig.* 7

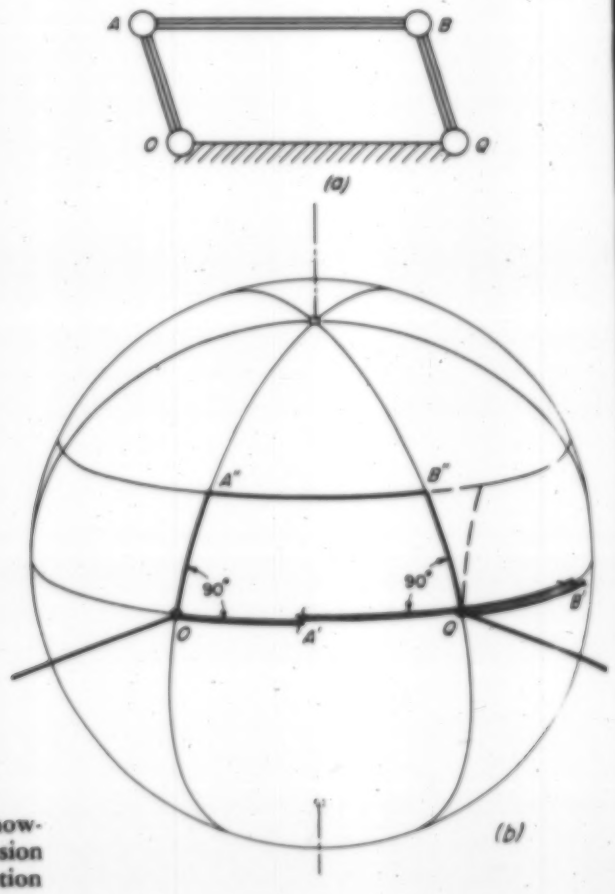


Fig. 10—Right—Two variations of parallogram linkage showing, *a*, plane form and, *b*, conic counterpart. Transmission of uniform velocity is not possible with the conic construction

a slider. The pin B now exists only in hypothetical form; it is 90 degrees to the left of A, and is the pole of the great-circle slot in link 3.

Viewed analytically, the mechanism shown in *Fig.* 9 consists of three 90-degree members and one acute-angle member (link 1). It is therefore an inversion of the universal joint, *Fig.* 7, which has three 90-degree members in motion and a stationary acute-angle (or obtuse) member for the frame.

Transmission of uniform motion from one shaft to another inclined shaft has long been a design problem. It is known that a single standard universal joint cannot provide the solution, although a pair of universal joints will give the desired result. Two recent developments, the Rzeppa and Bendix-Weiss types of universal joints, satisfy the condition but they are not conic quadric linkages.

With four links, it is really not possible to transmit uniform motion. This condition becomes clear when the parallelogram mechanism is considered. The plane parallelogram is shown in *Fig.* 10*a*, its conic counterpart in *Fig.* 10*b*. For the latter, let it be assumed that the links are in the dead-center position, $OA'B'Q$, to start. If link OA' is turned through 90 degrees to reach OA'', B' cannot move to the corresponding position, B'', which is the 90-degree position, since the distance $A''B''$ must be shorter than OQ and $A'B'$.

Bibliographical Note: The earliest description of the full variety of conic quadric chains is given by Reuleaux.[1] In the translated version of his book, however, the following note appears: "It was Willis who first pointed out the nature of the conic crank trains. He called the trains 'solid angular linkwork,' and indicated several of their more important forms and characteristics."

Willis's book,[2] of which the first edition came out in 1841, does not show the variety displayed by Reuleaux; he shows a wooden device with hinged planes which suggested the form of pivot B in *Fig.* 3. Later books describing conic chains (other than Hooke's joint) have also been published.[3,4] No mention of these mechanisms has been made in any of the textbooks on mechanisms recently published in the United States, with one exception.[5] On the other hand, an example was shown in an article appearing in MACHINE DESIGN as recently as February, 1954.[6]

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Training Programs for Graduate Engineers

THE area of creative technology—applied research, development, and systems and design engineering—is uniquely the area where the graduate engineer is inadequately prepared for the professional career on which he embarks.

Experience, accompanied by collateral observations, has led to some general conclusions about educational requirements and the training to meet them for creative technology. These conclusions may be summarized as follows:

1. Four-year engineering training, independent of the nature of the curriculum, is inadequate for a professional career in creative technology.

2. The larger the basic science (physics, chemistry, mathematics) content of the curriculum, the better is the course for those preparing for creative technology.

3. For the specific development, design, and engineering areas of creative technology, an industry can well provide the four-year engineer with the additional training required.

4. For the research and fundamental development areas of creative technology, training to the doctorate level in science or engineering is most desirable. A man planning to enter these areas can hardly afford, in his own interest, to have less training.

5. Training to this level is best done in an academic institution. Industry cannot provide the environment and stimulation of a graduate school.

6. While there is need for more men trained to the doctorate level in both science and engineering, the shortage in engineering is much more pronounced. Increased training to the doctorate level in engineering is a national need of major importance.

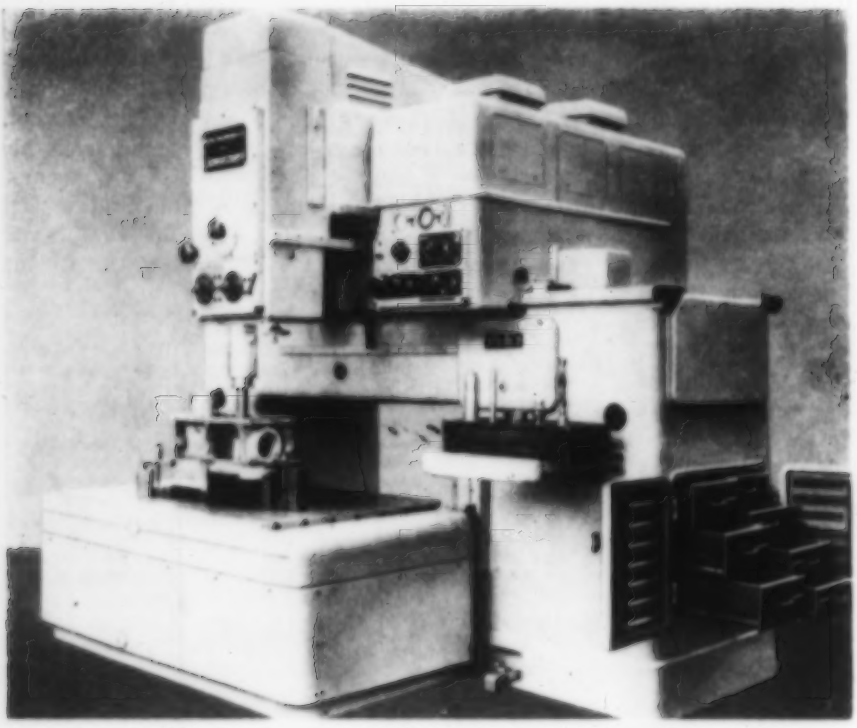
7. The enticing opportunities for graduate engineers, occasioned by our present relatively low engineering school enrollment and the ever-increasing demands for engineers, do not provide a good national environment for graduate training in engineering. The needs for the added training to the doctorate level should be more generally recognized, especially by our engineering faculties.

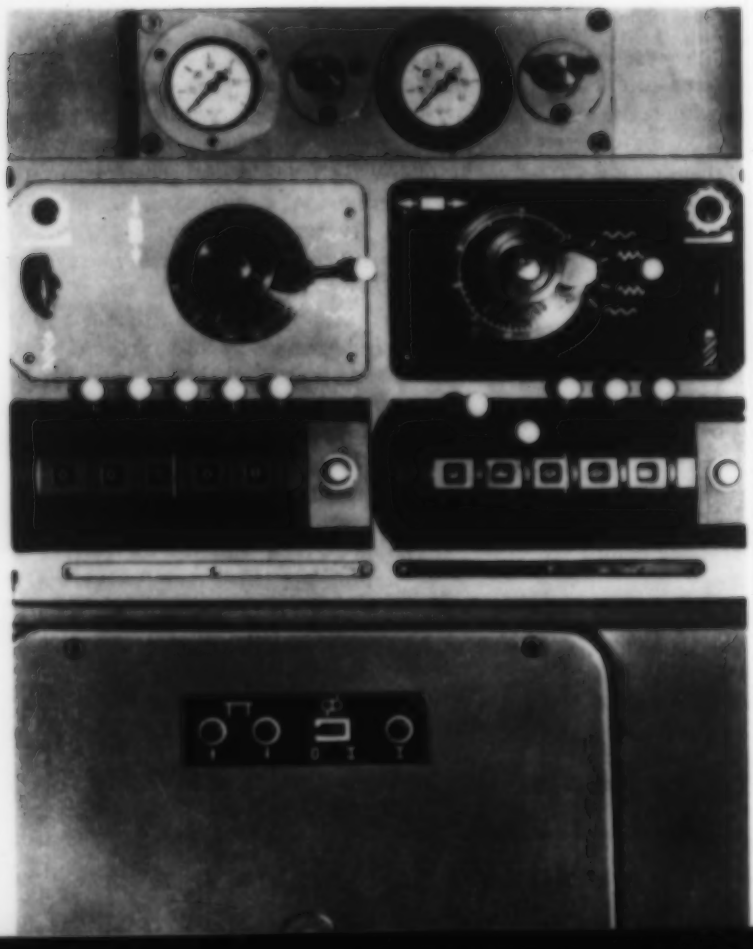
8. The projected increase in college enrollment, almost double by 1970, coupled with the effort to increase the percentage of entrants choosing science and engineering, does not provide a good environment for increasing the basic science content of engineering curricula or for markedly increasing the number of engineers continuing to the doctorate level.

Abstracted from a talk entitled "Training Programs of Industry for Graduate Engineers," by Dr. M. J. Kelly, president, Bell Telephone Laboratories.

Contemporary Design

MILLING-BORING MACHINE HAS



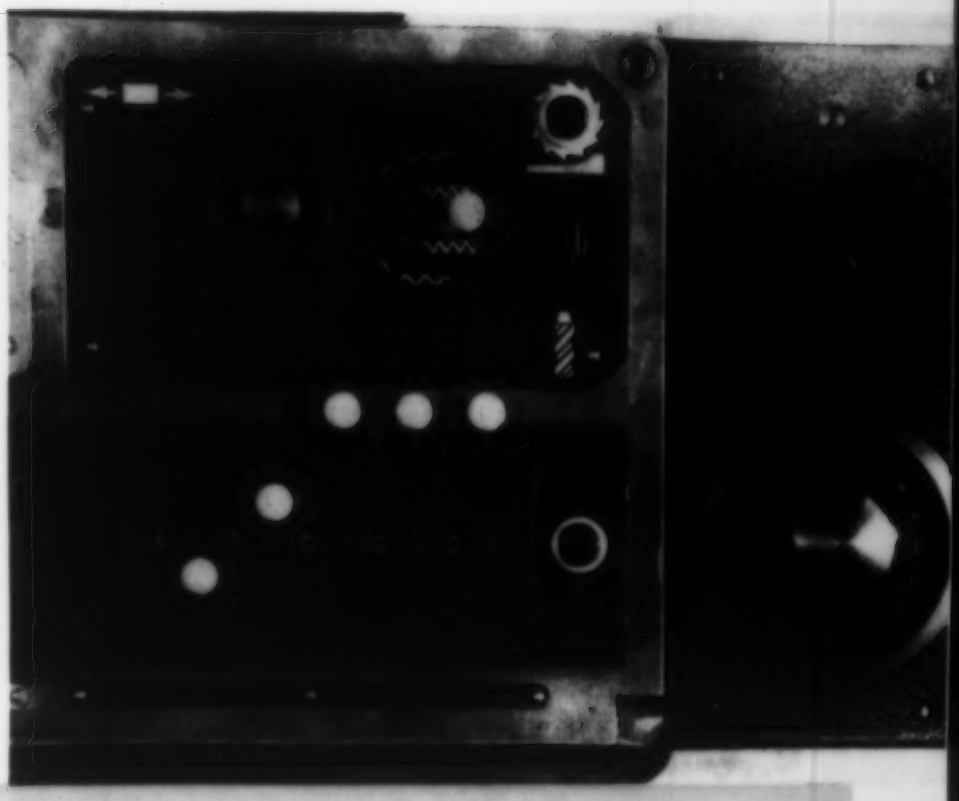


A RECENTLY introduced precision vertical boring and milling machine has as one of its outstanding design features fully automatic positioning of the head. Co-ordinates may be dialed by the operator or a punched-card program director may be used to control repetitive operations. Spindle speeds and feeds are also automatically pre-selected by turning dials to actuate limit switches and electromagnetic clutches corresponding to the desired speed. Working stroke of the spindle is 13 inches; maximum drilling capacity in mild steel is 2-inch diameter; maximum boring diameter is 10 inches; and maximum milling-cutter diameter is 4¾ inches. Both milling feed and rapid traverse are hydraulically performed. The milling feed is continuously variable from 0 to 14 inches per minute. The machine is manufactured by Berliner Maschinenbau Actien-Geselschaft Vormals L. Schwartzkopff, Berlin, Germany, and is distributed in this country by Marac Machinery Corp.

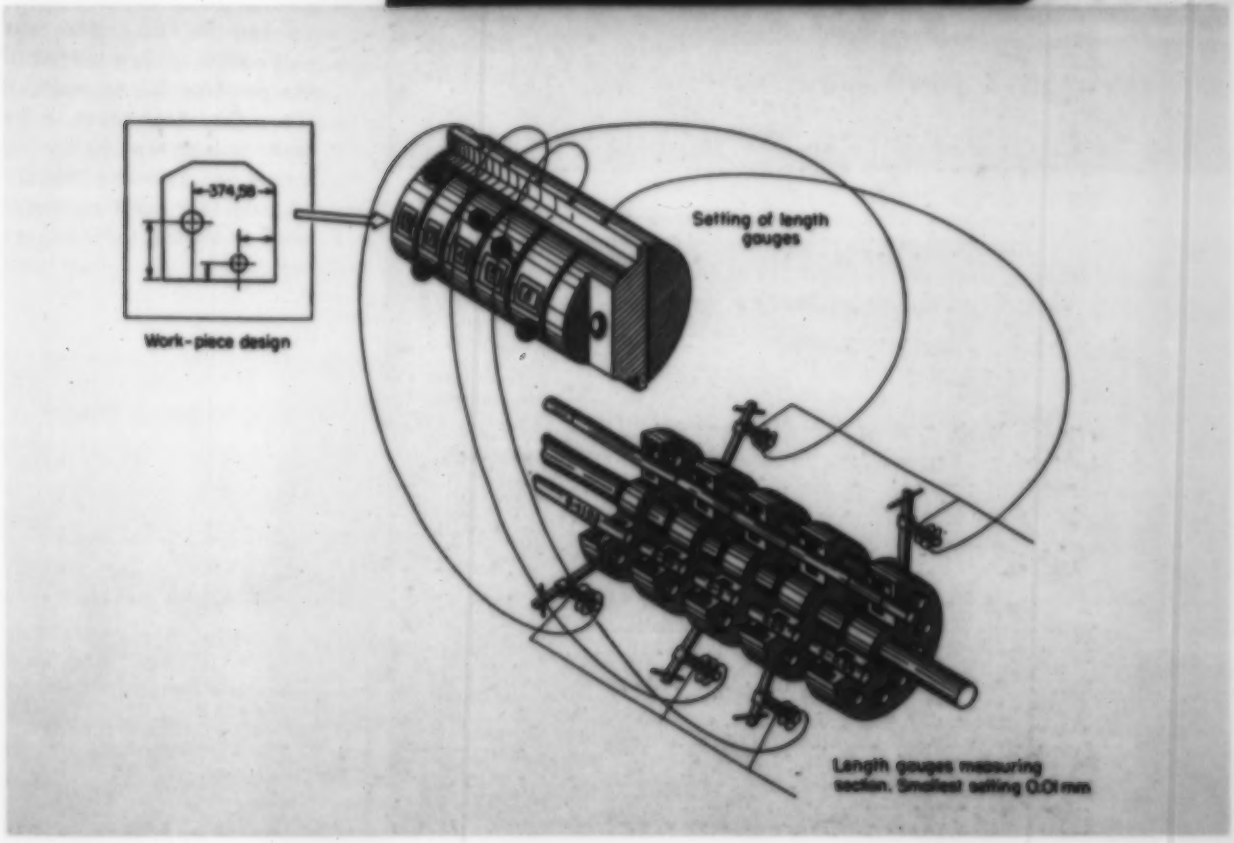
Control panel placed at convenient operating height incorporates preselector dials for feeds and speeds, selector switches for milling or boring, feed and speed selection controls, and meters to show torque being exerted by the machine while cutting. Pre-

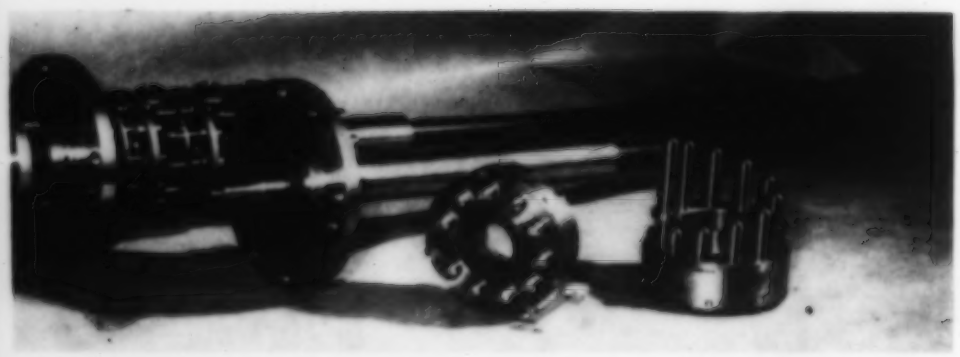
AUTOMATIC PRESELECTION

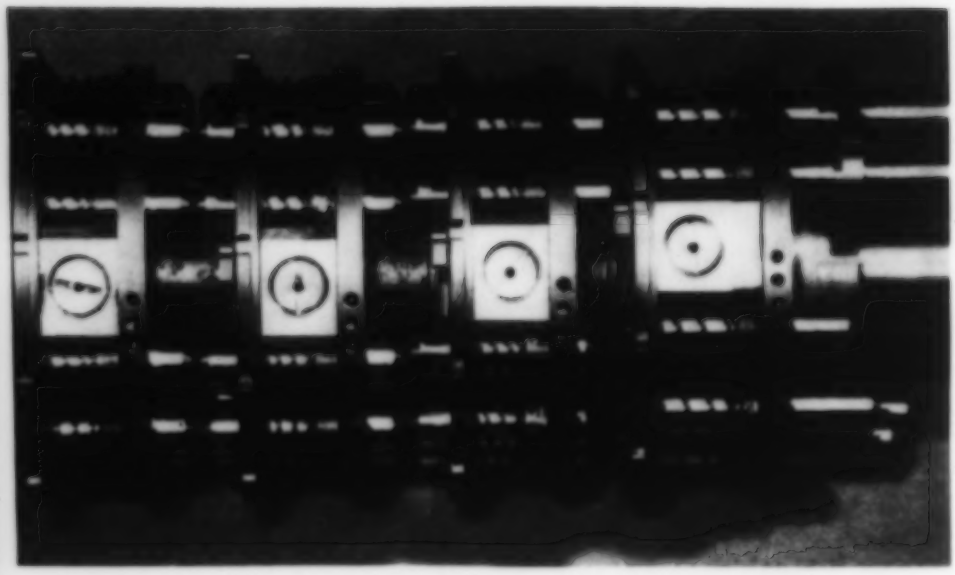
selector drums for boring co-ordinates are set by the ten small white ball handles. The smallest dimension which can be set is 0.0002-inch. The closeup shows the dial for controlling a 12-hole punched-card program. A selector switch directly above the dial permits interruption of the programmed operations at any time by simply turning from the *P* or program position to the *S* or single-operation position.

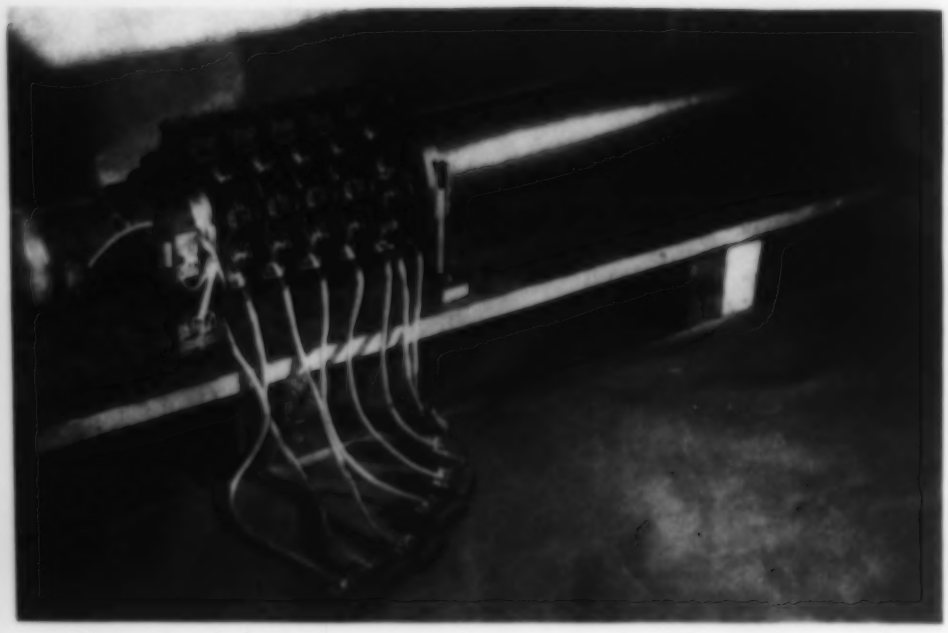


Co-ordinate preselection can be performed either by rotating selector drums on the control panel or auto-

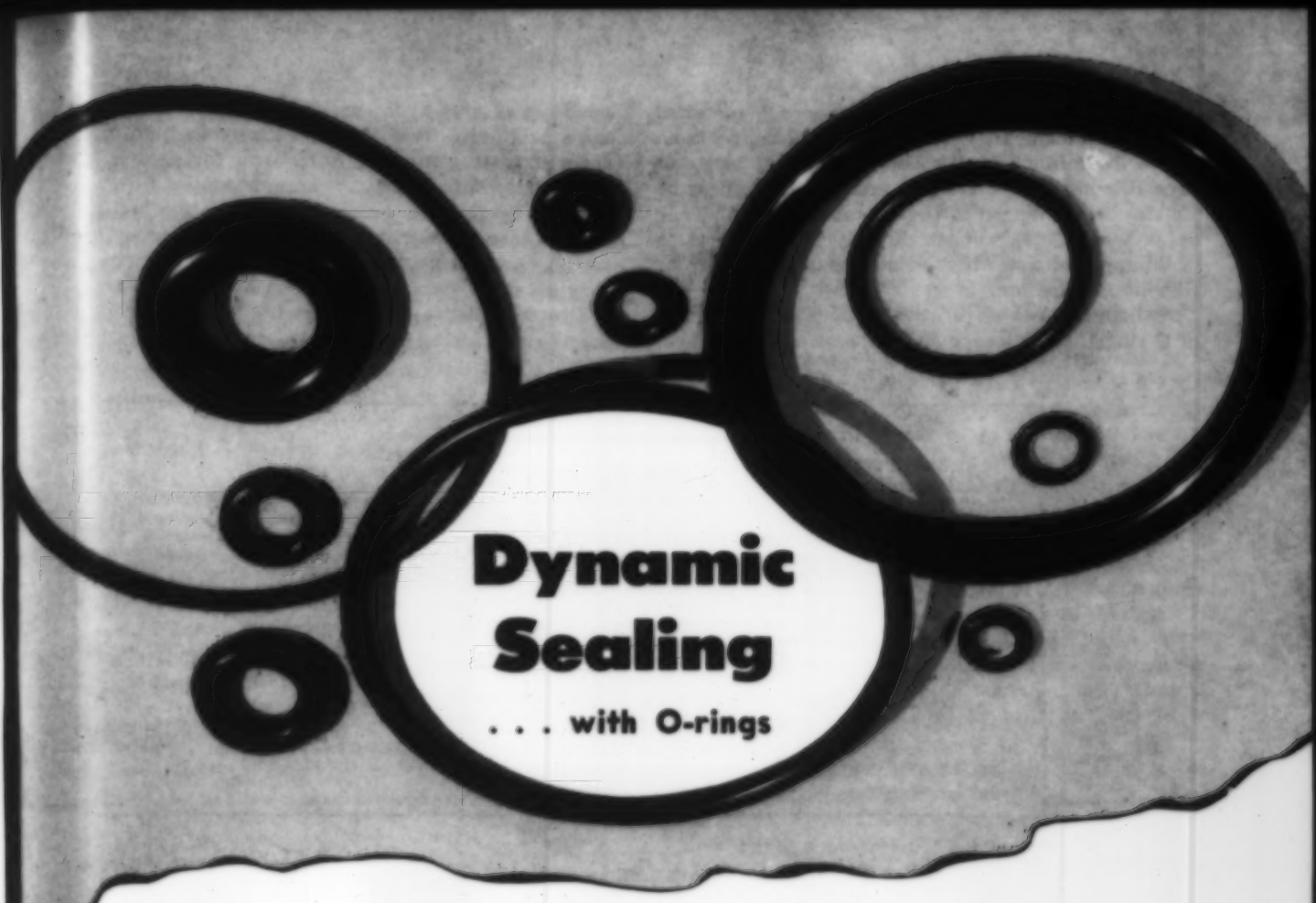








matically by punched-card plugboards. In either case, contacts actuated by the drum or circuits made in the plugboard energize solenoids corresponding to a particular length. Another set of drums (five for metric systems, six for English) contain measuring rods corresponding to the selected lengths. These drums are revolved by a small electric motor until the selected solenoid engages a notch in the periphery of the drum. When the five or six selected solenoids have engaged their respective notches, measuring rods equalling the required distance are lined up end to end. The machine slide is then moved to the position "measured" by the rods. Any point in an area measuring 50 by 30 inches can be automatically selected for drilling, tapping or boring by this system.



Dynamic Sealing

. . . with O-rings

By Clarence Johnson, *President, Hydro-Pneu-Tronics Inc., Cleveland, Ohio*

ONE of the important tasks of hydraulic and pneumatic engineers is the never-ending search for better packings and seals for cylinders and shafts. Static seals are now handled fairly well by a number of methods but a completely satisfactory universal moving seal is still a will-of-the-wisp.

The last decade has seen the O-ring become popular as a seal, because it is simple, tight, cheap and compact. From time to time other shapes of synthetic rings have come on the market, but while some apparently have merit, they have never achieved the popularity of the simple O-ring. One reason may be that some of these shapes are patented and many users hesitate to depend upon one source of supply.

As static seals, O-rings have been almost universally successful. That is not true of dynamic applications. Most unsatisfactory installations can be traced to misapplication, improper design and

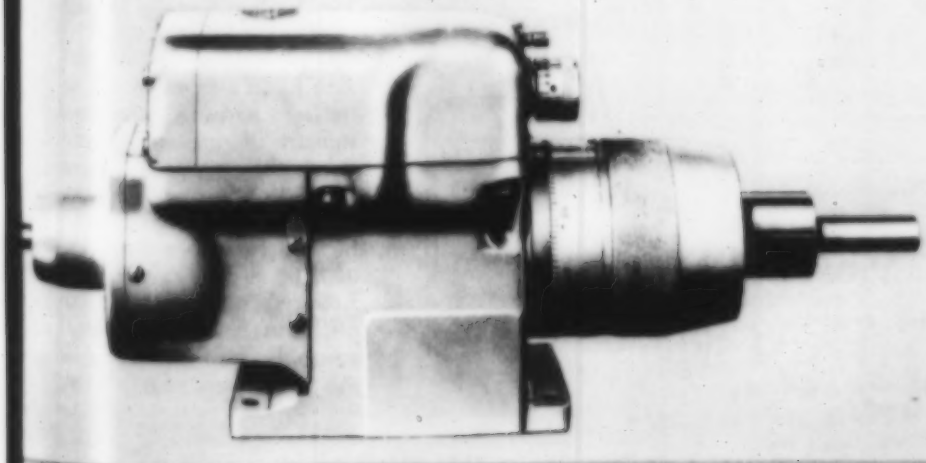


Fig. 1 — O-rings are successfully used both as dynamic and static seals in this hydro-pneumatic drill unit. Pistons sealed with O-rings separate the air section from the hydraulic section. Designed for use with air pressures of 70 to 120 psi, the unit has thrust capacity from 350 to 600 pounds. Photo, courtesy The Hartford Special Machinery Co.

maintenance. If correctly engineered, installed and maintained, an O-ring seal should give from 10 to 15 million cycles before showing any appreciable signs of increased leakage, regardless of its size or the length of the operating stroke. Wear rates seem to be almost directly proportional to the number of times the O-ring starts to move from its stopped position.

Although there have been many successful uses of O-rings in fields such as low-pressure hydraulics, pneumatics and hydro-pneumatics, *Fig.* 1, O-rings were originally used almost entirely in high-pressure aircraft systems. Standards for O-ring installations, *Table* 1, *Fig.* 2, were developed for such usage. In aircraft, temperature variations of 200 to −65 F must be met. Expansion and contraction of the O-ring compound under these conditions is very great. This, in combination with normal manufacturing tolerances, requires high compression of the O-ring during assembly at room temperature

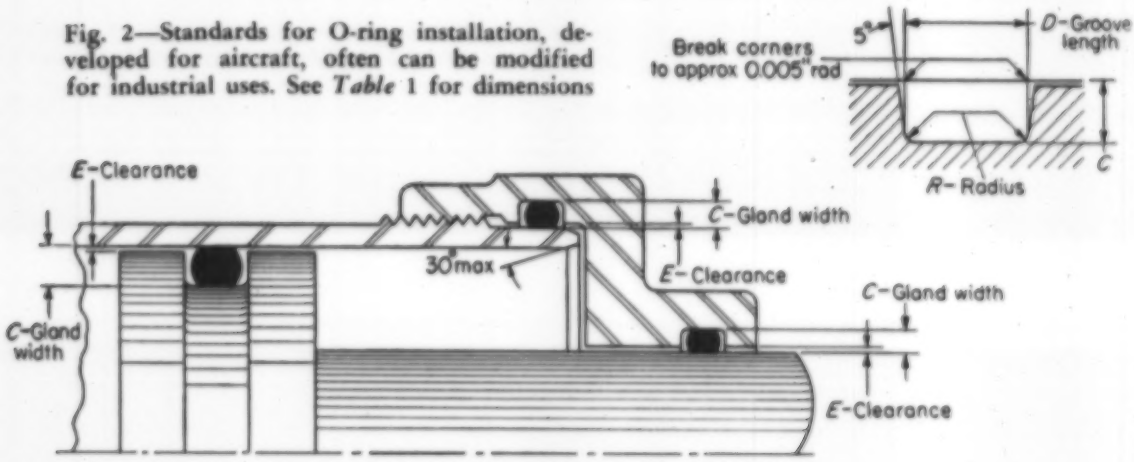
Table 1—Standards for O-Rings*

AUG.

O-Ring Specification Dash No.	O-Ring Section Diam	Diametral —Squeeze, min— Moving	Diametral —Squeeze, min— Static	C —Gland Width— Moving†	C —Gland Width— Static‡	D Groove Length	R Radius, min	2E Diametral Clearance, max
AN-6227								
1 to 7	0.070±0.003	0.010	0.015	0.057	0.052	3/32	1/64	0.006
8 to 14	0.103±0.003	0.010	0.017	0.090	0.083	9/64	1/64	0.005
15 to 27	0.139±0.004	0.012	0.022	0.123	0.113	3/16	1/32	0.006
28 to 52	0.210±0.005	0.017	0.032	0.188	0.173	9/32	3/64	0.007
53 to 88	0.275±0.006	0.029	0.049	0.240	0.220	3/8	1/16	0.008
AN-6230 Gaskets								
1 to 52	0.139±0.004	....	0.022	....	0.113	3/16	1/32	0.006

All dimensions in inches. *See *Fig.* 2 for explanation of dimensions. †Tolerance: +0.000, −0.001. ‡Tolerance: +0.000, −0.005.

Fig. 2—Standards for O-ring installation, developed for aircraft, often can be modified for industrial uses. See *Table* 1 for dimensions



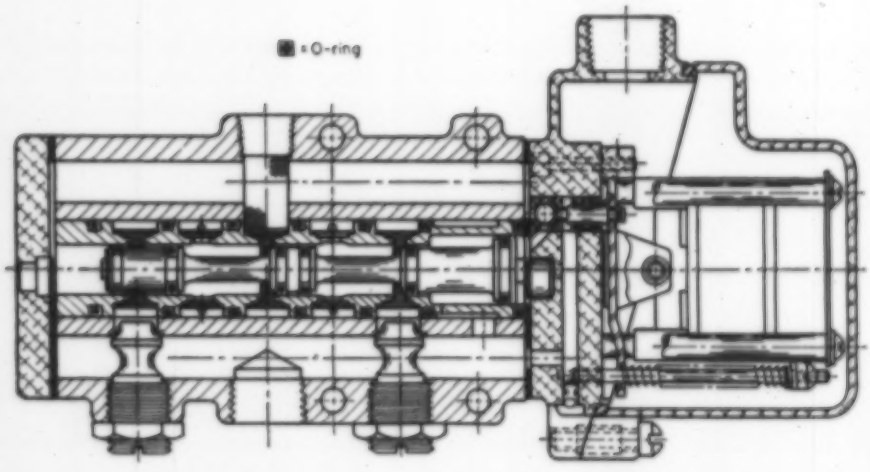


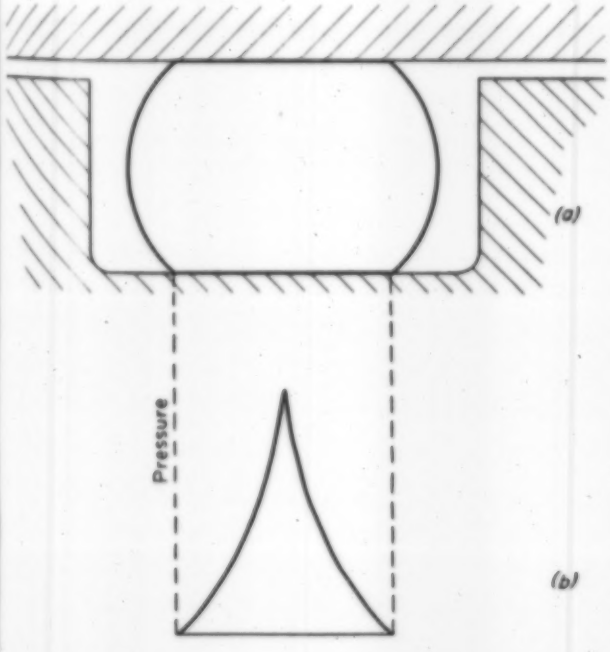
Fig. 3—Some of the O-rings used to seal the spool of this pneumatic or low-pressure hydraulic valve are installed with a diametral squeeze of one-half to one-third the standard recommendation, others are floating seals. Sealing is satisfactory for more than 15,000,000 cycles in life tests. Reduced squeeze also simplifies insertion of the spool assembly into the bore of this Bellows Co. valve

to prevent total loss of squeeze and seal under operating conditions.

Experience has shown that these specifications are not always necessary and may often be undesirable in medium and low-pressure work and where such temperature extremes do not exist. Often the squeeze may be reduced to one-half or one-third of that in the standard specifications, as in the valve shown, *Fig.* 3. Reducing squeeze may increase seepage slightly but it greatly reduces friction also. Usually the squeeze on a piston sealing ring may safely be reduced since the slight film of oil will simply be transferred from one side of the piston to the other.

Some O-Ring Idiosyncrasies: The O-ring has some characteristics that differentiate it from other types of packing. One of these is its peculiar wiping action as a seal. On very thin oils and at slow speeds, it wipes practically dry. At higher speeds it does not wipe as dry. It does not wipe heavy oils as dry as thin oils, hence permits greater leakage with heavy oil. After a period at rest under any condition the *break-out* friction increases with time usually up to one hour.

Fig. 4—When the O-ring is compressed in its groove, *a*, pressure upon it is as shown at *b*. Extremely high pressure at the center of the ring causes it to key itself into the contacting surfaces, if the ring is stationary for a prolonged period. Should the stationary period be sufficiently long, the O-ring may form a chemical bond with the contacting surfaces. Either of these circumstances greatly increases *breakout* friction



When an O-ring is subjected to cross-sectional squeeze it assumes a shape somewhat like that shown in *Fig.* 4*a*. Unit pressure is highest at the middle of the ring and falls off toward the edges. The exact relationship is not known, but it is probably something like the graph shown, *Fig.* 4*b*. There always exists, therefore, an inherent pressure gradient or *squeeze out* that urges the oil film out from under the ring toward the edges. When the ring is moving it *sleds up* on the oil film and some of it is left clinging to the shaft; the faster the motion, the thicker the film. When motion stops, however, the relentless resilient pressure of the ring causes the ring to sink through the oil film; the middle section of the O-ring soon touches bare metal and the coefficient of friction changes abruptly. As time goes on, more and more of the ring comes down to bare metal and the ring itself begins to displace oil from all the microscopic imperfections in the metallic surface and to key itself in them. Break out friction is then at its maximum value.

If the O-ring remains immobile and under cross-sectional squeeze for some time, such as would occur when the apparatus of which this ring is a part is in storage or transit, the O-ring may occasionally form what appears to be a slight chemical bond with the contacting surface. A very great change in pressure is then required to break it loose.

Occasionally an O-ring twists in the groove during service and sometimes continues to do so until it becomes chewed to pieces. The actual cause has never been explained satisfactorily. It may be that this failure is caused by the uneven *squeeze out* of the oil around the periphery of the ring which sets up uneven frictional forces between the walls and the ring. Such uneven *squeeze out* may result from a number of causes such as uneven cross-sectional squeeze owing to the eccentricity of the O-ring groove and the cylinder, uneven thickness or hardness of the O-ring or just the vagaries of an oil film.

Considering the very weak torsional resistance of the standard O-ring, it seems amazing that this does not happen more often. The normal groove is wide enough to permit the ring to rock slightly at the start of the reversal. In a sense the ring acts like a roller bearing between the piston and the cylinder at the start of the stroke. It is prevented from continuing to roll by the side of the groove. When the ring meets the side of the groove, the side of the groove sweeps the ring along and it slides on the cylinder wall because combined torsional resistance of the ring and friction of the side and the bottom of the groove are normally higher than the frictional force against the cylinder wall. Normally this rolling action adds greatly to the life of the ring by distributing wear. If the friction of the cylinder wall is higher than the combined friction of the bottom and side of the groove, and the torsional resistance, then

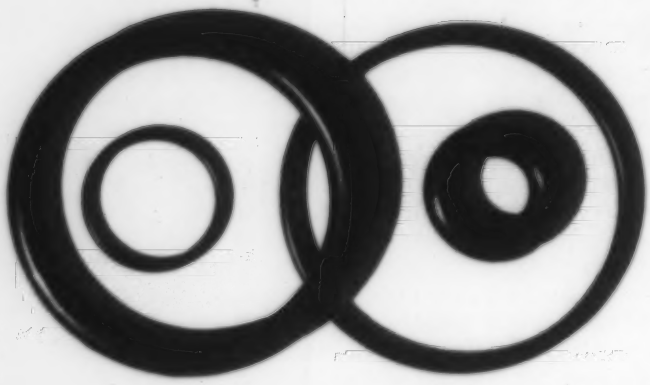
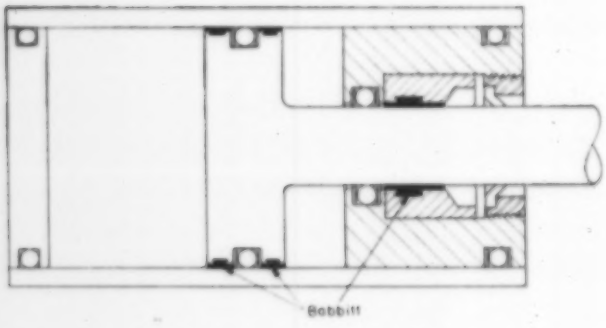


Fig. 5—Above—O-rings having low ratios of outside diameter to cross-section resist twisting in their grooves. A 1⅝-inch OD ring with a 4 to 1 OD to cross-section ratio and a 4-inch OD ring with 0.412 cross-section are shown as well as the standard cross-section rings

Fig. 6—Below—When the metallic surfaces sealed by an O-ring must contact each other the surface containing the O-ring groove should be a soft bearing material. Both babbitt and nylon have been used successfully for this purpose. Suggested construction using babbitt is shown here



the ring will turn in its groove. On the piston rod itself the rolling action probably does not occur because the pressure is always in one direction and the ring is always forced against one side of the groove.

The only sure cure for twisting is to increase the torsional stability of the ring. This may be done by increasing the hardness or the cross section of the torus. It would seem that there should be some definite relationship between the outside diameter of the ring and its cross section probably something like ten to one to insure this torsional stability. Rings of this ratio and even higher ratios, *Fig.* 5, are in use in some sizes. Certain O-ring manufacturers have molds for many such non-standard sizes.

The friction of such heavy cross-section rings is said to be high, but there are no published data on this point. Since rings of this proportion have more *body* they might also be applied to good advantage in equipment such as road and agricultural machinery where O-rings are usually considered too delicate.

Design Suggestions: Certain design procedures have been found to result in maximum life of O-rings used as dynamic seals. First of these is the specification of proper finish for the surface against which the O-ring slides. The surface should be ground, honed or polished to a surface roughness of 8 to 10 microinches. Values within this range seem to give longer life than either rougher or smoother finishes. A finer finish does not seem to result in longer life, presumably because microscopic grooves which serve as oil reservoirs are removed. After the initial finishing, the surface should be hard chrome or nickel plated and again polished. Plating imparts a hard slippery surface that resists corrosion, wear and scratching. However, the surface must be smooth before plating since the plate itself cannot remedy a poor finish. In general the plate should be at least 0.002-inch thick. Flash plating is not always satisfactory since it may wear through or peel off.

Metallic surfaces sealed by an O-ring preferably should never touch, but if they must, then the one containing the O-ring groove must be a soft bearing material. It is impossible to run a highly polished piston rod through a hard bearing without inflicting scratches on the rod. It is likewise impossible to slide a hard piston in a highly polished cylinder and not inflict scratches on the cylinder wall. The scratches are probably caused by small hard particles loosened and picked up by the oil which sooner or later become jammed between the moving surfaces and cut them. Though they may be hairlines, they are, nevertheless, longitudinal scratches and will reduce sealing efficiency and life of the O-rings.

The most satisfactory bearing material tried for this purpose is babbitt. The babbitt forms an excellent bearing and the hard particles become imbedded and captured in it without damage to the hardened rod. In fact after millions of cycles the babbitt imparts a glass-like finish to the rod. Nylon may also be used as a bearing material, but the bearing must be split in some fashion to allow for nylon's relatively high coefficient of thermal expansion.

In a suggested design, *Fig.* 6, the piston is surfaced with babbitt. The gland is also lined with babbitt. The O-ring may be located in the babbitt lining or in the supporting metal as shown. If it is located in the supporting metal, this metal should be relieved 0.002 or 0.003-inches so there will be no chance of the hard metals running together.

While back-up rings are not considered necessary for pressures below 1500 psi they seem to give the

O-ring a certain amount of protection and are usually worth installing.

Free-floating pistons such as used in accumulators, etc. may ride on two O-rings, *Fig. 7*. With high pressures, the space between the O-rings should be vented to one end of the piston or the other, the end next to the lubricant being preferred. With low pressures this may not be necessary, or desirable.

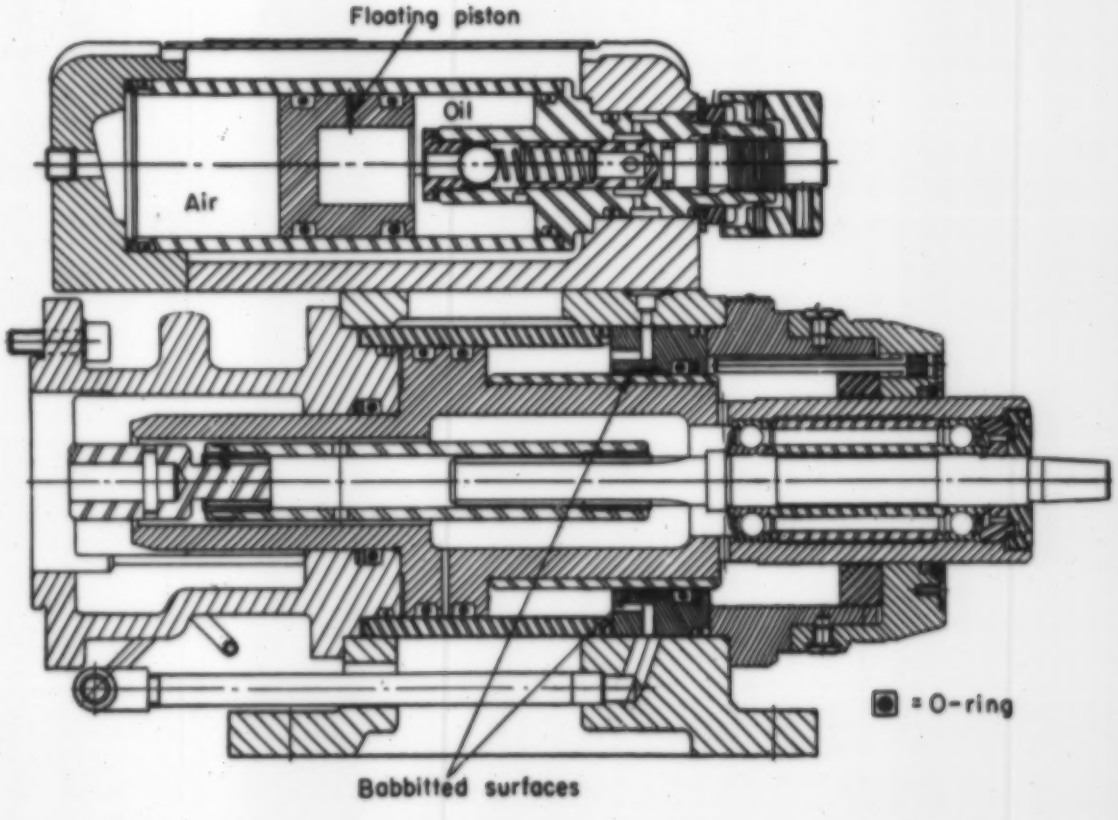
A hydraulic or pneumatic system must be assembled under as clean conditions as possible and must remain clean thereafter. It is always desirable when possible to design a hydraulic system as a unit. In that way the hydraulic system is shipped completely sealed and the customer need not open up the system to pipe it.

Foreign material can and will enter every opening so all breather openings should be equipped with filters. Foreign material and air will sometimes enter around the pump shaft, especially when the suction to the pump is increased. Vertical mounting of the motor and pump is usually desirable and the oil level should be maintained between the motor coupling and the pump shaft gland.

Filters, while solving some problems, introduce others. As a rule filters must be installed on the suction side of the pump because their shells will not stand high pressures. For this type of work a fabric or yarn construction is generally preferred because it gives a defense in depth. In order to keep the pressure drop down it may be necessary to use several filter cartridges in parallel. Some of the new powdered metal filters that can be applied in the pressure lines also seem to be working out quite well although they do not filter as finely as the cloth or yarn ones do.

In spite of all instructions and cautions, customers will connect air-operated devices directly to the air lines without benefit of either filters or lubricators. Twenty-five years ago the industrial instruments manufacturers were up against the same situation regarding their air-operated control equipment. Eventually the customer learned that cleaning up his air supply by means of good compressors, aftercoolers, separators and filters was the best and cheapest preventive maintenance. As the use of pneumatic equipment continues to grow industry must learn that air good enough for chip

Fig. 7—Two O-rings are used here to prevent metal-to-metal contact of the floating piston and cylinder wall in this hydro-pneumatic drill unit. The piston separates air and oil sections of the unit. Where metal-to-metal contact could not be avoided, the surfaces of the part containing the O-ring groove are babbitted. Use of the babbitt bearing surfaces is estimated to have increased piston and O-ring life from a few thousand to millions of operating cycles. Drawing, courtesy The Hartford Special Machinery Co.



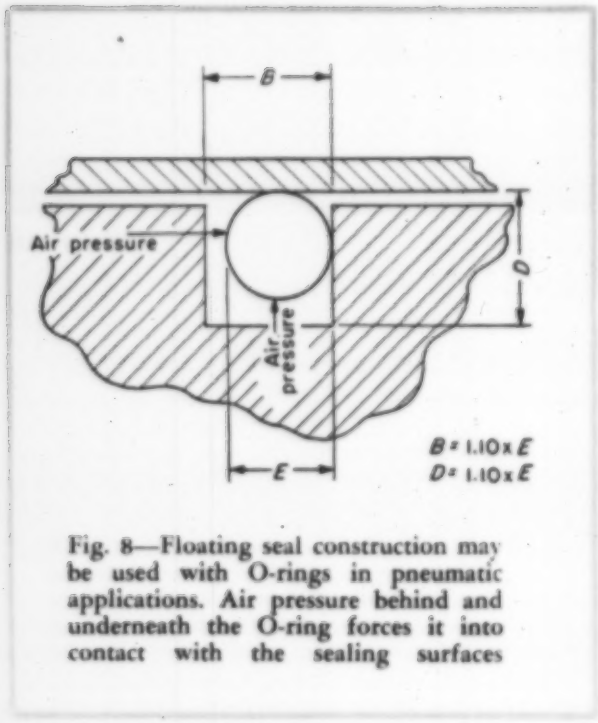


Fig. 8—Floating seal construction may be used with O-rings in pneumatic applications. Air pressure behind and underneath the O-ring forces it into contact with the sealing surfaces

blowing and sand blasting is not necessarily good enough for valves and cylinders.

Composition of a hydraulic oil or pneumatic lubricating oil and the O-rings must be carefully matched. During the past years there have been radical changes in the compounding of oils by the use of additives. This has made it impossible to tell from the appearance of an oil what it contains. As a result, the tendency to use any oil of approximately the desired viscosity, which might have been all right a few years ago is now a risky procedure.

The addition of detergents, antifoaming, antivarnish and other compounds has created serious hazards insofar as rubber compounds are concerned. Some of the additives cause certain rubber compounds to swell and others to shrink. In some applications the plasticizer has been so completely extracted from the O-ring that the ring became hard and brittle, and broke when dropped. If the O-ring manufacturers know what oil the ring will be used in they can generally supply a compound in the ring that will be stable against that particular oil.

Pneumatic System Considerations: In some ways the use of O-rings for pneumatic applications is simpler than in hydraulic systems and in other ways it is more difficult. A slight leakage of air usually is not objectionable, although a new ring generally will seal bubble tight.

Frictional resistance of O-rings may become a large part of a pneumatic cylinder's load unless special precautions are taken. It becomes expedient, therefore, to greatly reduce the cross-sectional squeeze of the O-ring or to remove it altogether.

In some applications the depth of the groove has been so proportioned that the cross section of the O-ring would just meet the bottom of the groove and the cylinder wall when the tolerances of the groove diameter and the ring cross section are at the minimum, and the cylinder at the maximum.

Another groove design that has been found satisfactory on pneumatic seals is the so-called *floating* seal. This design uses no cross-sectional squeeze at all. The depth of the groove should be about 10 per cent greater than the cross section of the O-ring and the inside diameter of the cylinder should be 1 to 5 per cent less than the outside diameter of the ring. The groove width is usually 5 to 10 per cent greater than the cross section of the ring, *Fig.* 8. In this design the air actually gets under the O-ring and forces it out against the cylinder wall and the side of the groove; the higher the pressure, the tighter the O-ring seals.

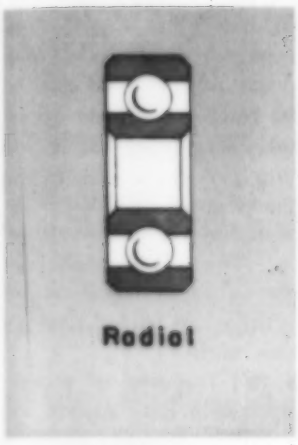
Summary: While the O-ring has been in common use for over a decade, new uses and occasional disappointments are continually occurring. O-rings were originally developed for aircraft and most of the literature is based upon aircraft requirements. Most industrial applications are not similar to aircraft since the former must run in millions of cycles where aircraft applications may run in thousands.

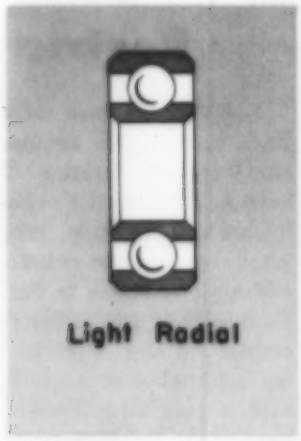
Often standard O-rings may not be best suited for industrial applications. It may, therefore, be the time to establish a new set of specifications for industrial applications. It may also be time for the O-ring to be subjected to some detailed mathematical analysis.

They Say . . .

"The engineer's practical applications of science have done much to make our American standard of living the highest the world has ever known. He has helped promote our national welfare and security and the health, comfort and prosperity of our citizens. In this technological age the nation's need for his services is constantly expanding. His responsibilities become greater every day, and in spite of manpower shortages, the engineering profession is achieving success in meeting the challenge."—DWIGHT D. EISENHOWER

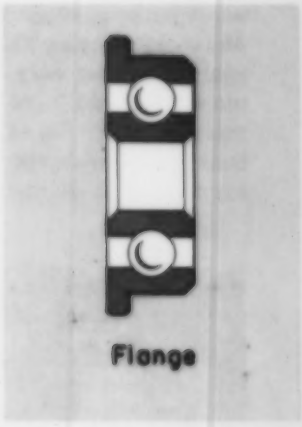
"We stand today at the gateway of what promises to be a great scientific revolution which will probably work a far greater change in our mode of living than the so-called industrial revolution has wrought in the past century or so. Most of us cannot even imagine the wonderful new devices and appliances that will become commonplace necessities of our daily life in the next few decades. And all of this—experience has shown—will mean more jobs, more purchasing power, more leisure, and a more comfortable life for our people."—BENJAMIN F. FAIRLESS, *chairman of the board, United States Steel Corporation.*





Design and Application Ideas for

Special Miniature Bearings



In some design situations, special miniature bearings are needed to handle jobs not possible with standard types. When, where and how to use these specialized bearings are outlined in this group of application ideas.

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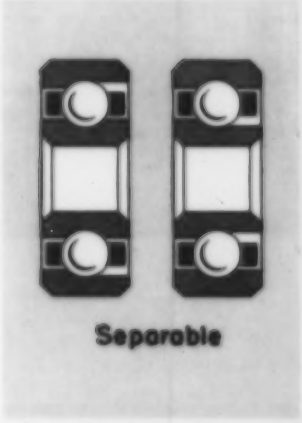
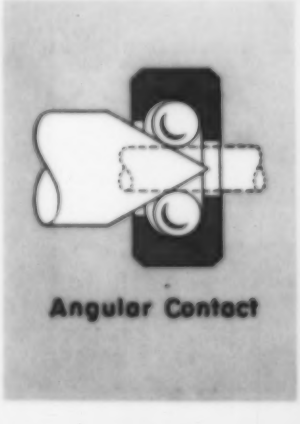


IN DEVELOPING special miniature bearings, it is usually good design practice to make as little change as possible in a standard bearing. Typical standard bearings are shown. The greater cost of special production equipment or tooling for a necessarily more complicated special bearing must be justified. Thus, most special bearings usually involve only slight changes in one or two basic bearing dimensions. But special miniature bearing designs can range from these minor dimensional changes, such as a wider outer ring, to packaged bearing assemblies where both the inner and outer ring are entirely integrated into the overall product design.



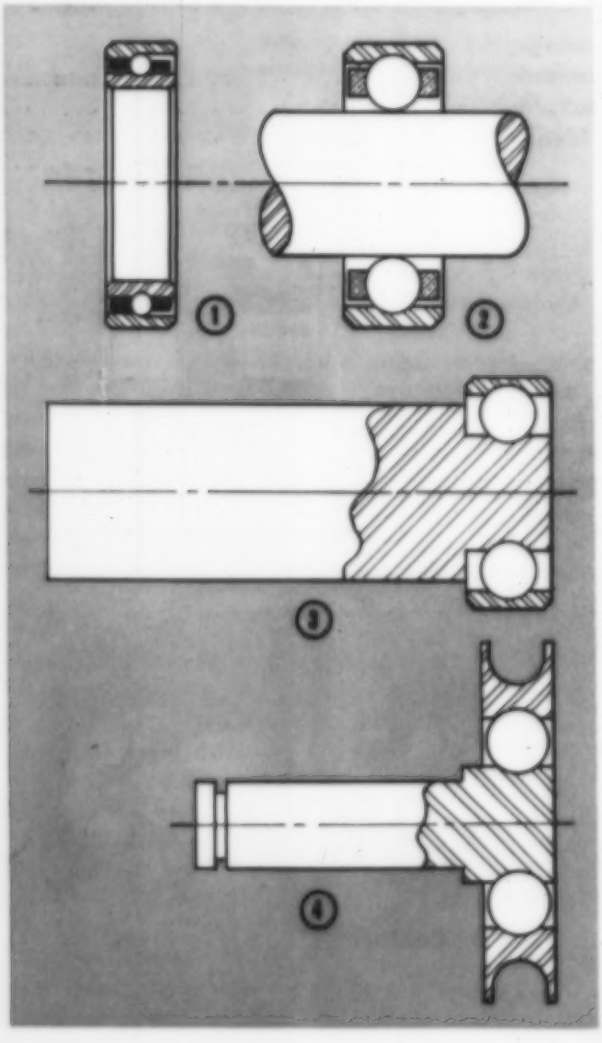
Limited Space

Often the required minimum shaft size and maximum housing inside diameter are so close that steps must be taken to fit the rings and balls within the space available. A bearing for supporting

a film-transporting driveshaft in an aircraft gun camera, *Fig.* 1, is designed to fit into a very limited space. Thicknesses of the inner and outer rings are reduced as much as possible while maintaining required radial load capacity. In addition, very small balls have been selected to reduce radial space. Because the balls travel a comparatively long distance per revolution (bearing OD is 0.5-inch and the speeds are high), a ball separator has been specified to eliminate the possibility of friction between balls. The ball separator is made of nylon because of the material's high wear resistance and self-lubricating characteristics.

The inner ring of the ball bearing can be eliminated completely, *Fig.* 2, where the radial space saving is more critical than the resulting axial freedom. Such a bearing requires a separator or retainer in order to facilitate assembly.

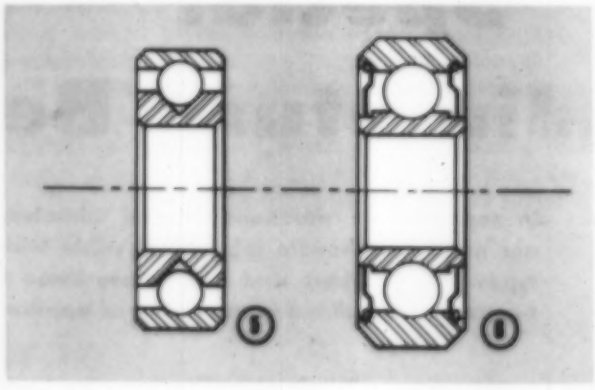
Inner races can be ground directly on a shaft. This has been done on a special gear stud, *Fig.* 3, in order to provide maximum shaft strength to support the gear mounted on the bearing outer ring. Since the bearing OD is limited by the size of the gear stud, the only solution was to eliminate the inner ring and have the balls roll directly around the shaft. In *Fig.* 4, the races are ground into a heavy section on the shaft because the requirement for full shaft diameter is critical.



Restricted End Play

A V-shaped race on the inner ring, *Fig.* 5, has been specified in applications where no axial motion can be tolerated. The use of standard miniature bearings with negative radial clearance (preloaded), a common method for eliminating axial play, may also be satisfactory, but running torques are higher. Balls in the special bearing run freely on two lines (on either face of the V) so that there cannot be any axial motion. The same result can be accomplished with a curved race whose diameter is only slightly larger than the ball diameter, but again friction would be high.

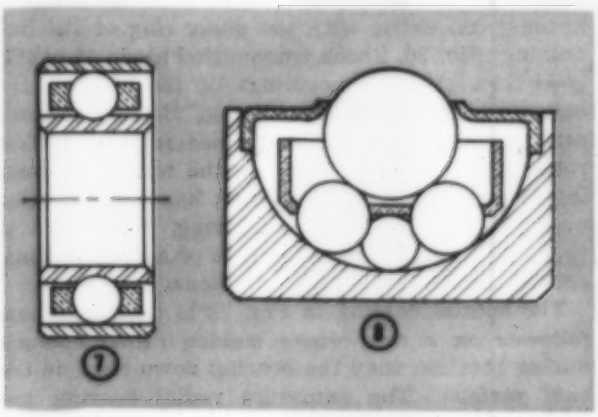
Precise positioning with full freedom of movement is provided in an adjustable lens mount by three special bearings, *Fig.* 6, which are subject to both radial and thrust loads. The 0.031-inch chamfers on either edge of the outer ring ride along the slanting sides of a groove in the periphery of the rotating lens holder. The bearings themselves are mounted in the instrument housing.



Free Motion

Free axial movement can be allowed by special designs. A miniature radial bearing used on one end of a small motor shaft, *Fig.* 7, permits shaft elongation with temperature rise while providing the required radial location. A large bearing on the other end of the motor shaft absorbs the thrust load that develops as the shaft expands and contracts. A standard radial bearing with very large radial clearance would allow enough axial play for the amount of shaft elongation involved, but would not provide the same degree of radial location.

The spherical bearing in *Fig.* 8 represents a radical bearing design necessary to solve a specific design problem. The bearing is actually a pivot type bearing with a built-in spherical pivot. Designed for a pneumatic bellows assembly in a miniature instrument, the special spherical bearing is designed to transmit motion between two levers with minimum friction. Because they do not rotate on the same axis, sliding (as well as rotation) takes place between the levers. Although this



sliding motion is small, hysteresis loss at the levers is sufficient to impair the accuracy of the device. The spherical bearing permits transmission of force between the two levers with imperceptible friction in either sliding or rotation.

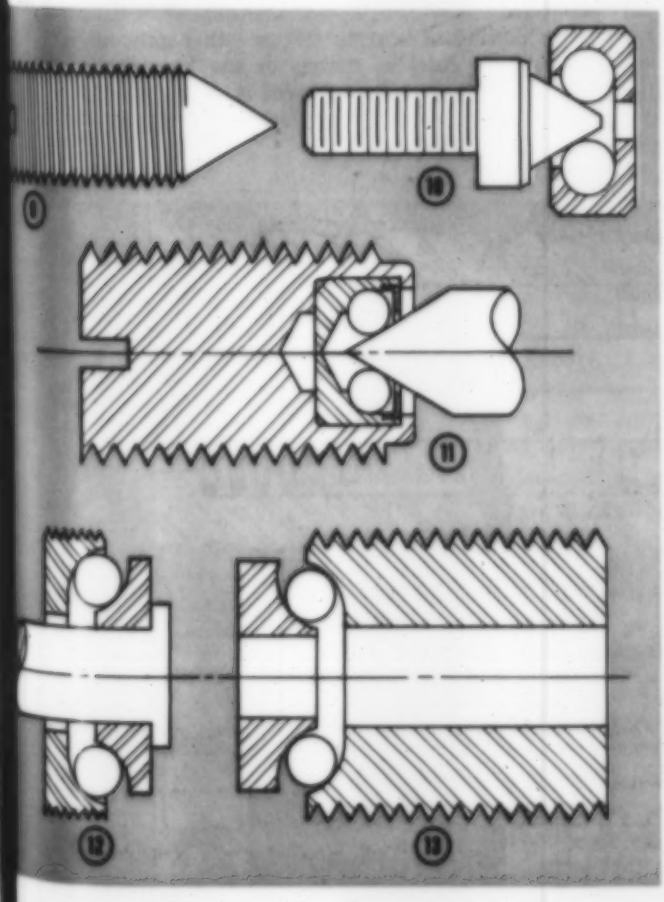
Axial Takeup and Pivot Types

In designing pivot-type bearings into precision mechanisms, the arrangement of the pivot (usually the cone has a 60-degree included angle) is extremely important. Tightness of fit between the pivot and balls in a pivot-type ball bearing is often very critical and often must be adjusted periodically during operation of the mechanism. The threaded pivot cone in *Fig.* 9 is designed for easy adjustment by turning with a screwdriver. Fineness of threads and locking arrangement selected depend on required precision of location.

The same type of threaded pivot cone may be designed with an enlarged section between the threaded shaft and cone, *Fig.* 10, used for adjustment. The only real difference from *Fig.* 9 is one of convenience in a particular mechanism.

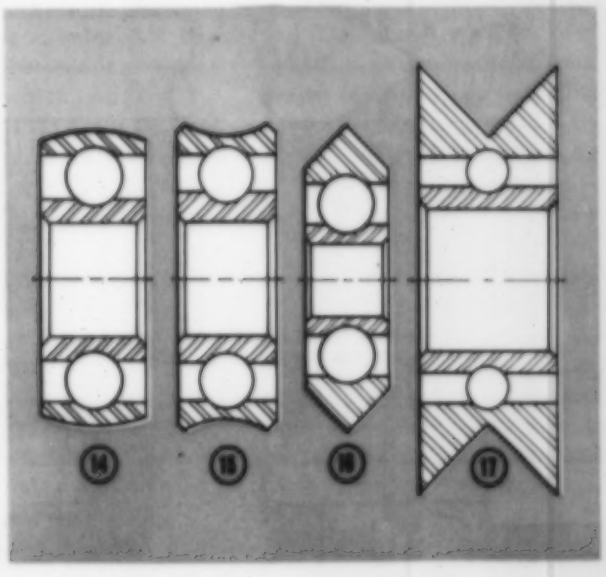
It may be more satisfactory in other designs to use a stationary pivot and make axial adjustments through the housing containing the pivot bearing itself. In *Fig.* 11, the outside surface of the housing has been threaded and a slot machined on one end for screwdriver adjustment.

While the bearing housing is threaded in *Fig.* 11, the spherical seat of the angular-contact bearing in *Fig.* 12 has been threaded. Slots for a spanner wrench are machined on the back of the seat, and the inner ring of the bearing is welded on the shaft. Longer and more precise adjustment in the same type of special bearing is provided by finer threads on an extended outer ring, *Fig.* 13.



Special Outer Races

While standard miniature radial ball bearings are frequently specified as cam followers, a miniature bearing with a spherical outer ring, *Fig.* 14, has been used as a cam roller to provide point contact, rather than line contact, with the cam. In very sensitive cam mechanisms, the saving in friction may justify the special bearing. An oval outer ring also eliminates any change in circumferential travel due to misalignment of the follower and cam. Misalignment with the flat outer ring of a standard radial bearing might result in the



bearing-roller riding on a chamfer edge.

The miniature radial bearing in *Fig.* 15 has a concave groove in the outer ring for supporting a shutter cable for a miniature camera. The miniature bearing fits within the space available in the camera and carries the pull cable around a right angle, with virtually no frictional loss.

A miniature bearing with a V-shaped outer ring, *Fig.* 16, locates and carries a pen carriage in a sound-measuring machine. The outer ring rides in a similar V-shaped horizontal way on the machine frame and permits the pen to move across the paper accurately in response to very small pulses. In *Fig.* 17, the V-shaped groove in the outer ring rolls on a V-shaped circular track in a level recorder. The V-shaped outer ring has also been used as a wire guide.

Shock-Resisting Designs

Severity of either intentional or accidental shock to the mechanism may be sufficient to justify special shock mountings for the bearings. An effective method of absorbing shock in a pivot-type bearing is the use of spring backing as shown in *Fig.* 18. The spring may be either a helical type or a Belleville or leaf spring. Optimum spring stiffness depends on the degree of shock expected. The spring provides both shock resistance and proper pivot-cone pressure. In *Fig.* 19, two miniature radial bearings supporting an instrument shaft have each been mounted against springs to prevent damage from a known axial shock in both directions.

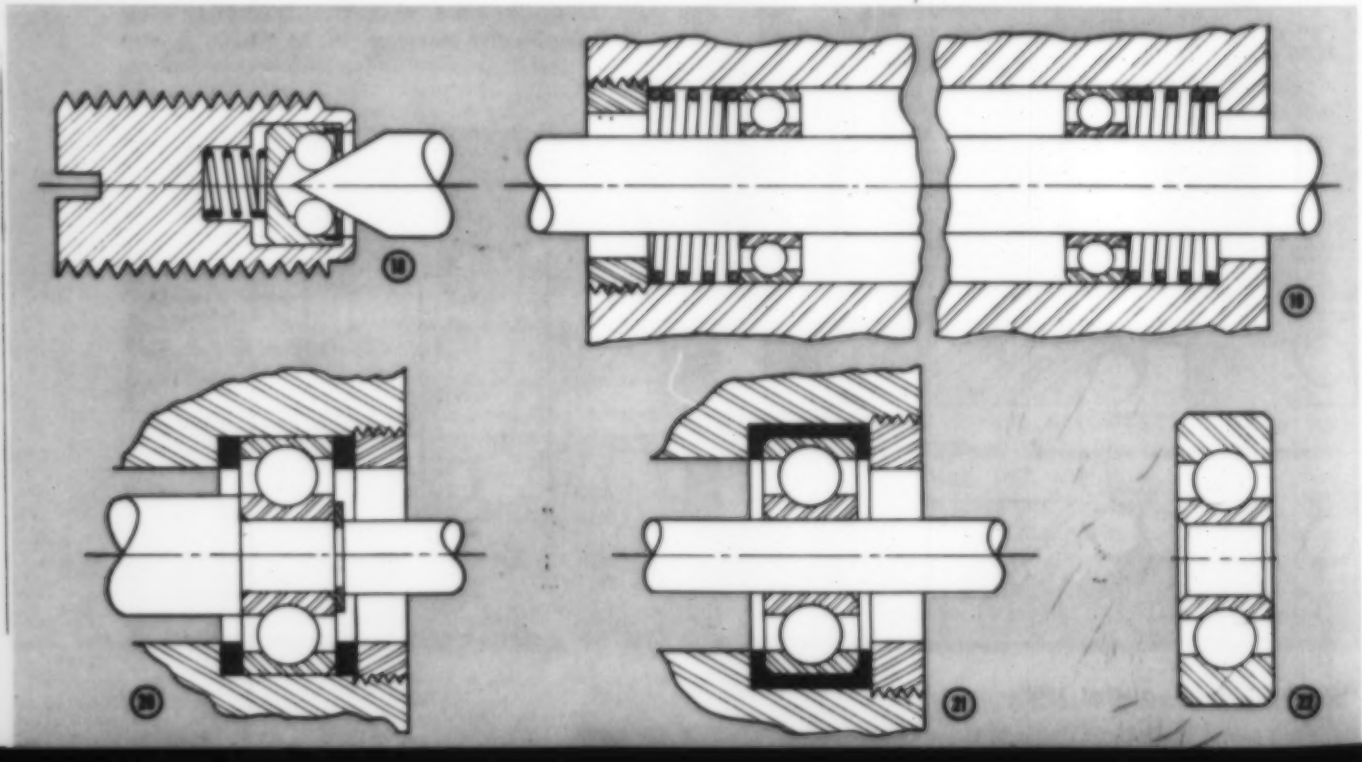
Another practical method for absorbing shock is to mount two rings of resilient material in the housing concentric with the outer ring of the ball bearing, *Fig.* 20. Shock transmitted along the shaft goes through the inner rings of the bearing, the balls and then to the outer ring. Before the balls can dent or brinell the outer race and impair free rotation, shock is absorbed by the resilient mounting. In *Fig.* 21, a rubber jacket has been mounted over the outside of the outer ring, in addition to the rubber rings on the sides, to provide additional shock absorption in all directions.

The special bearing in *Fig.* 22 is used as a cam follower on a cam where sudden radial changes during rotation snap the bearing down hard on the cam surface. The miniature radial bearing has been specified with an exceptionally thick outer ring to minimize cracking and distortion.

Special Materials

In applications where operating conditions require that bearings be run without lubrication, it is necessary to make both rings and balls of a material which will not soften at the very high temperatures produced by running friction. High-speed steel, which retains its hardness at temperatures up to 1000 F, is used so that the bearings are able to sustain load without distortion. Other special materials used for rings and balls have included:

1. Sapphire balls for isolating electric current between the inner and outer rings.
2. Beryllium-copper balls and rings for nonmagnetic characteristics.
3. Chrome-carbide balls for high temperature application.
4. Silver plating of bearing OD as either galvanic seal or for uniform fitting in the housings.
5. Gold plating of balls to prevent fretting corrosion and to slow down spark jumps in a magnetic field.



Designing to withstand

High-Impact Shock

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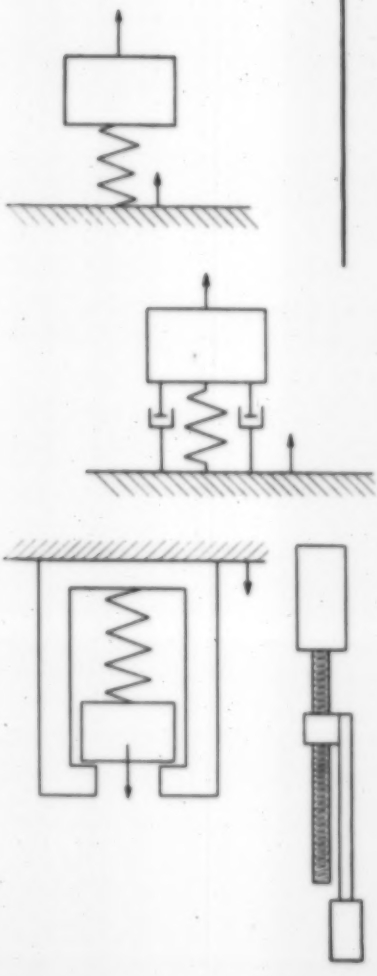
PERFORMANCE of mechanisms which are designed to operate under high-impact shock is often difficult to evaluate. Attempts to make a complete theoretical analysis of the problem may become hopelessly complicated. Usually the most satisfactory and practical design approach consists of using simplified assumptions and employing empirical methods based on test data.

One simplified method of designing for high-impact shock is the use of a "design acceleration factor." Field experience and laboratory tests on shock machines show that equipment will usually survive if designed for a force of a certain number of times its own weight. The design acceleration factor is a function of the weight of the part and its natural frequency of vibration. Heavy pieces can be designed with lower acceleration factors than light pieces. Flexibly mounted parts have a better chance of survival than rigidly mounted parts provided the mounting is not so flexible that the part "takes off" with a high velocity and then suddenly hits against a stop.

When actual accelerations are measured in firing tests, for example, peak values recorded by instruments are usually considerably higher than those used successfully as design acceleration factors. There are several reasons for this discrepancy, some of which are not too well understood. One is the effect of rate of loading on yield strength, and another is the short duration of the applied acceleration. Analysis of oscillograms shows that if the shock phenomenon must be simplified into a function which can be handled mathematically, it is not satisfactory to assume that shock consists of a suddenly applied acceleration which persists for an appreciable time.

An assumption which comes much closer to reality is the "starting velocity" concept. It assumes that the piece of equipment is accelerated up to some finite velocity in a negligible length of time and then maintains that velocity during the initial and most important phase of the shock motion. Analyses made by this method give results which correspond with good accuracy to experimental data obtained from instrumentation of objects shocked by underwater explosions and shock-testing machines. The "starting velocity" concept is considerably more difficult to apply in design work than the "design acceleration" concept since it requires calculation of the natural frequencies of the structure being studied. For calculating the strength of a part, the simpler "design acceleration" concept is often sufficient, but for calculating elastic displacements or relative motions between parts of a mechanism the "starting velocity" concept must be used.

The following cases cover the application of the "starting



HIGH-IMPACT SHOCK

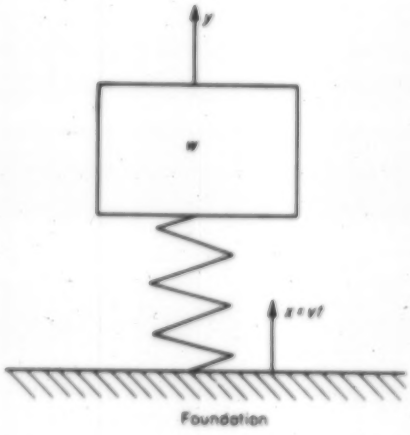
velocity" concept to some typical mechanisms. Case I deals with a spring-mounted member without damping while Case II covers damped members. A spring-loaded member with a rigid stop is discussed in Case III. The examples given for Cases II and III show that the proposed devices were unsatisfactory. These examples are given to illustrate the fact that sometimes flexible devices such as springs and magnetic fields are unable to hold sufficiently under shock conditions. Holding devices often must be rigid or be balanced in such a way that motions are opposed by the inertia of other parts of the mechanism. Case IV is an example of the successful use of inertia and mechanical multiplication of the spring stiffness.

Case I—Spring-Mounted Member without Damping

Problem: A mass is mounted on a foundation by means of springs. Assume that the foundation is instantaneously accelerated to an upward velocity which thereafter remains constant. What is the maximum stress created in the spring and its attachments?

Nomenclature:

- g = Acceleration of gravity, in. per second^2
- k = Spring constant, lb per in.
- t = Time, seconds
- v = Starting velocity, in. per second
- W = Weight of mass, lb
- x = Upward displacement of foundation from initial position, in.
- y = Upward displacement of mass from initial position, in.
- ω = Undamped system natural frequency, radians per second $= (kg/W)^{1/2}$



Solution: Maximum relative displacement between the mass and its foundation must be found to calculate spring stress.

The vertical forces are in equilibrium when

$$\frac{W}{g}\frac{d^2y}{dt^2} = k(x - y) \quad \ldots\ldots (1)$$

or

$$\frac{W}{g}\frac{d^2y}{dt^2} + ky = kx \quad \ldots\ldots (2)$$

At the initial conditions, $t = 0$, $y = 0$, $x = 0$, and $dy/dt = 0$. At $t = 0$ and thereafter $x = vt$. The complete solution of Equantion 2 for these conditions is

$$y = vt - \frac{v}{\omega}\sin \omega t \quad \ldots\ldots (3)$$

Since $x = vt$,

$$y - x = -\frac{v}{\omega}\sin \omega t \quad \ldots\ldots (4)$$

and

$$(y - x)_{max} = \frac{v}{\omega} \quad \ldots\ldots (5)$$

Even though the foundation is given an infinite acceleration, the maximum acceleration of the mass is

$$\left(\frac{d^2y}{dt^2}\right)_{max} = v\omega \quad \ldots\ldots (6)$$

Maximum force on the spring is

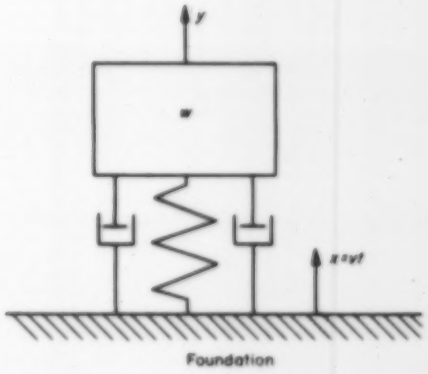
$$k(y - x)_{max} = v\sqrt{\frac{Wk}{g}} \quad \ldots\ldots (7)$$

This equation can then be employed to calculate stress in the spring and its attachments.

Case II—Spring-Mounted Member with Damping

Problem: A mass is mounted on a foundation by means of springs as in Case I, except that a viscous (linear) damping device is added. Assume the initial conditions and imposed motion are the same as for Case I. Determine the amount of damping required to limit the relative displacement of the mass and foundation.

Nomenclature: Same as in Case I plus:
c = Damping coefficient, lb per in. per second
q = Damped natural frequency, radians per second



Solution: The damping device resists motion of the mass relative to the foundation with a force proportional to the relative velocity between the two. When the mass and foundation are in equilibrium, the relationship of vertical forces is

$$\frac{W}{g}\frac{d^2y}{dt^2} + c\left(\frac{dy}{dt} - \frac{dx}{dt}\right) + k\,(y - x) = 0 \qquad (8)$$

For damping less than critical,

$$c < 2\sqrt{\frac{k\,W}{g}} \qquad (9)$$

and the instantaneous value of relative displacement is

$$y - x = -\frac{v}{q}\,e^{-(cg)/(2W)}\sin qt \qquad (10)$$

where

$$q = \sqrt{\frac{kg}{W} - \left(\frac{cg}{2W}\right)^2} \qquad (11)$$

For critical damping,

$$y - x = -v\,t\,e^{-qt} \qquad (12)$$

The value of $y - x$ is a maximum when

$$\tan qt = \frac{2\,q\,W}{c\,g} \qquad (13)$$

for subcritical damping and is a maximum when

$$t = \sqrt{\frac{W}{k\,g}} \qquad (14)$$

for critical damping.

Example: The plunger in an electric solenoid must not be allowed to move more than 1.5 inches from a central position. This restriction is imposed because of the possibility of loss of plunger control and failure to return the plunger to a central position. The plunger and parts attached to it weigh 60 pounds. The magnetic force increases at the rate of 100 pounds per inch for plunger motions up to approximately 1.5 inches in either direction from a central position. The force starts to decrease at distances greater than 1.5 inches. Determine if shock motions can be limited to less than 1.5-inch displacement by using hydraulic damping.

Assume the magnetic force in this case acts like a spring since for small motions the force increases linearly with displacement of the plunger from its central position. Thus W = 60 pounds, k = 100 pounds per inch, and assume v = 120 inches per second. The table shows that even with 100 per cent of critical damping, the device is not satisfactory. If a 2-inch displacement were permissible, 75 per cent of critical damping would have been sufficient.

Plunger Displacement for Various Degrees of Hydraulic Damping

Damping (per cent of critical)	Damping Coefficient c, (lb/in./sec)	Damped Natural Frequency q, (radians/sec)	Plunger Displacement $(y-x)_{max.}$ (in.)
0	0	25.4	4.73
25	1.97	24.6	3.35
50	3.94	22.0	2.58
75	5.91	16.85	2.08
100	7.88	0	1.74

Case III—Spring-Loaded Member with Rigid Stop

Problem: Determination of maximum movement of mass of weight W under impact conditions of Case I, except accelerations are downward.

Nomenclature: Same as in Case I except positive displacements and forces are downward.

Solution: Assume the rigid stop is adjusted so that the compression spring exerts a force of F pounds on the weight when the system is at rest. This force is to prevent the weight from leaving the stop when the foundation of the system is disturbed. When a disturbance has a finite value of peak acceleration, this adjustment can be set by making F/W greater than the ratio between the disturbing acceleration and the acceleration of gravity. Sometimes the design acceleration factor is used for this ratio, but this assumption is too optimistic to be correct. For high-impact shock the actual peak acceleration may be several times as large as the required design acceleration, and it is not practical to make the spring force large enough to stop the motion completely. For most cases it is better to accept the fact that some motion of the weight relative to the stop will occur. The amount of motion can be calculated from the starting velocity concept and allowed for in the design.

Case IV—Lead-Screw Drive

Problem: Determination of maximum movement under impact.

Nomenclature:

- F = Force exerted by rotating mass on translating mass, lb
- I = Moment of inertia of rotating part, lb-in.^{2}
- k_m = Equivalent spring scale of motor field, in.-lb per radian
- R = Radius at which masses are coupled, in.
- v = Starting velocity produced by shock, in. per second
- W = Weight of translating part, lb
- x = Downward displacement of rotating mass, in.
- y = Downward displacement of translating mass, in.
- θ = Angular displacement of rotating mass, radians

Solution: A lead-screw drive for changing rotational motion into slow speed linear motion is shown in drawing *a*. The lead screw is connected directly to the armature of an electric motor, and rotation of the nut is restrained by a guide. The motor is a reluctance type in which the armature poles follow the motion of a rotating field. The motor imposes a holding torque which acts like a torsion spring on the lead screw even when the field is not rotating. For purposes of analysis a dynamically equivalent system consisting of a rotating mass geared to a translating mass is shown in drawing *b*. When high-impact shock occurs, assume the rotating mass is displaced downward with some given starting velocity, v. The starting velocity of the translating mass is neither v nor 0 as occurs in a flexible coupling. The starting velocity of the translating mass is the result of an inelastic impact at the point of coupling, and is dependent on the relative inertia of the rotating and translating masses. Starting velocity is given by the expression

$$v_o = \frac{v\,I}{I + WR^2} \qquad (20)$$

The equilibrium equation for the translating mass is

$$\frac{W}{g}\,\frac{d^2y}{dt^2} = F \qquad (21)$$

and for the rotating mass is

$$\frac{I}{g}\,\frac{d^2\theta}{dt^2} = -k_m\,\theta + FR \qquad (22)$$

Since $x - y = R\theta$ and $x = vt$, Equations 21 and 22 reduce to

$$\frac{I + WR^2}{g}\,\frac{d^2y}{dt^2} + k_m\,y = k_m\,vt \qquad (23)$$

Assume the zero-displacement position of the weight is taken as its position against the stop. The equilibrium equation of forces on the weight is

$$\frac{W}{g}\frac{d^2y}{dt^2} + k\left(y - \frac{F}{k} - x\right) = 0 \quad \ldots (15)$$

The solution for y is

$$y = -\frac{v}{\omega}\sin\omega t - \frac{F}{k}\cos\omega t + vt + \frac{F}{k} \quad (16)$$

The distance of the weight from the stop at any time t is $y - x$ and is given by

$$y - x = -\frac{v}{\omega}\sin\omega t - \frac{F}{k}\cos\omega t + \frac{F}{k} \quad (17)$$

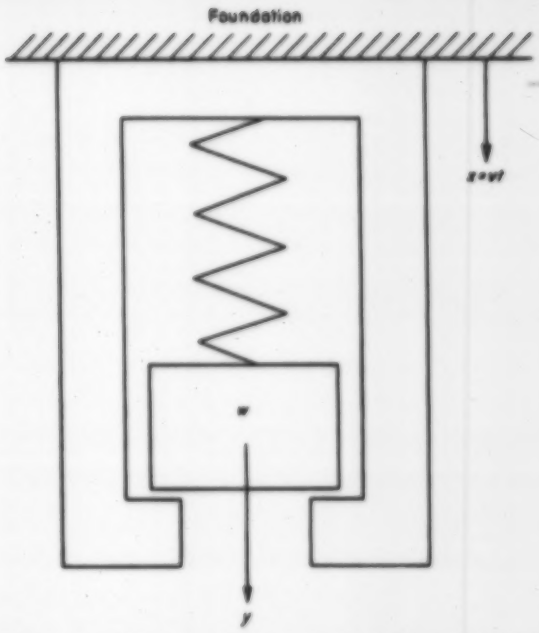
The maximum value of $y - x$ during the first half cycle of vibration is

$$(y - x)_{max} = \sqrt{\frac{v^2}{\omega^2} + \frac{F^2}{k^2}} - \frac{F}{k} \quad \ldots (18)$$

or

$$(y - x)_{max} = \frac{1}{k}\left(\sqrt{\frac{v^2 Wk}{g} + F^2} - F\right) \quad (19)$$

Example: A trigger mechanism has an 86-pound weight which is held in the cocked position against a rigid stop by a 100-pound spring force. The spring rate is 20 pounds per inch. It is acceptable for the weight to jump off the stop during shock by a small distance—approximately ⅛-inch. Assume k = 20 pounds per inch, W = 86 pounds, g = 386 inches per second² and F = 100 pounds. Take v to equal 120 inches per second. From Equation 19, $(y - x)_{max}$ = 8.65 inches which is so far from being satisfactory that no practical spring design could stop the motion.



For the initial conditions $t = 0$, $y = 0$ and $dy/dt = v_o$ the solution for the relative displacement between the translating mass and the rotating mass is

$$y - x = \frac{v_o - v}{\omega_n}\sin\omega_n t \quad \ldots (24)$$

where

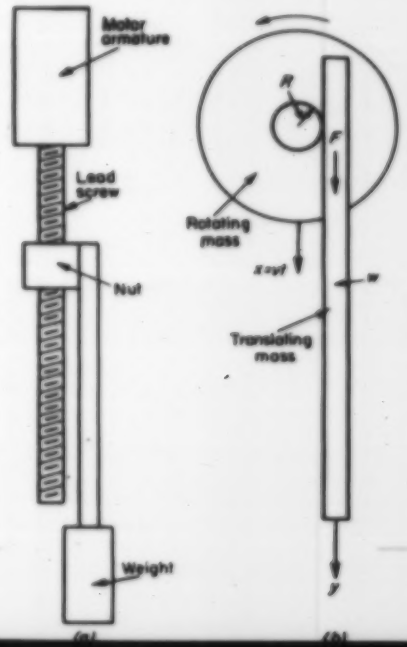
$$\omega_n = \sqrt{\frac{k_m g}{I + WR^2}} \quad \ldots (25)$$

Therefore

$$(y - x)_{max} = \frac{v_o - v}{\omega_n} \quad \ldots (26)$$

Equation 26 can be applied to either the lead screw device in drawing *a* or the rack and pinion in drawing *b*. When used for the lead screw design, the radius of the pinion pitch circle, R, is equal to the pitch of the lead screw divided by 2π.

Example: A ball nut and lead screw is to be used for vertically positioning a weight. The moment of inertia of the rotating part, I, is 25.5 pound-inches², the weight of the translating part, W, is 54 pounds, and the lead screw pitch is ⅜-inch. The motor has a four-pole armature with 3 foot-pounds peak holding torque. Thus the magnetic torque changes from 0 to its maximum value in $\frac{1}{16}$ of a revolution. Therefore $k_m = (36 \times 16)/2\pi = 91.9$ pound-inches per radian. Inserting this value of k_m in Equation 25 shows ω_n = 37.4 radians per second. If v is assumed to be 120 inches per second, and Equation 20 is employed, v_o = 119.1 inches per second. Then from Equation 26, $(y - x)_{max}$ = 0.024-inch. This calculation is pessimistic because it assumes zero friction in the ball nut. Therefore, the motion of the nut relative to its support under shock conditions is negligible.

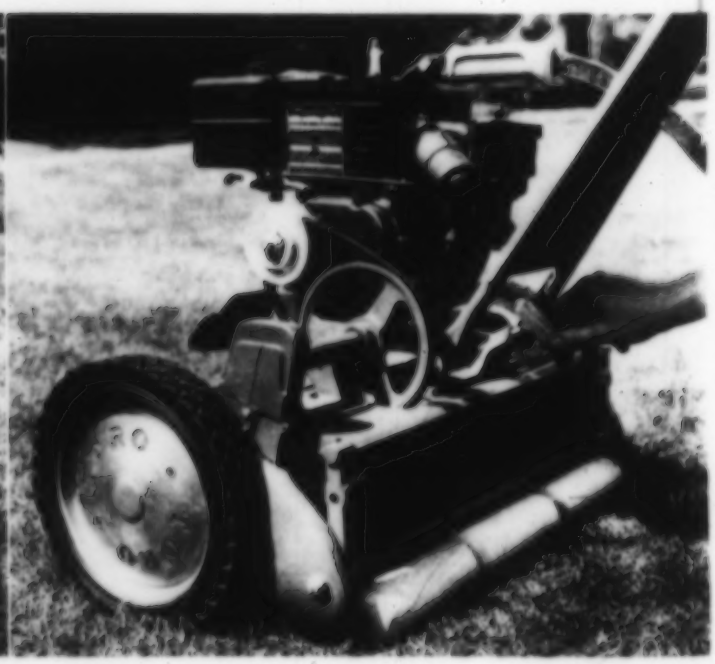


Contemporary Design

New Concept Applied to Mower Design

A NEW concept has been applied in the design of the Power Handle, a self-contained unit incorporating a 2¾-horsepower Briggs and Stratton engine which may be attached to any one of five basic operating components now being produced in 20 seconds. The five units are: a 21-inch self-propelled reel-type lawn mower; a 20-inch self-propelled rotary-type lawn mower and leaf mulcher; a 17-inch tiller; a trimmer-edger; and a 17-inch snowplow. According to the manufacturer, Toro Mfg. Corp., price of the Power Handle and one of the five attachments exceeds the price of a conventional one-piece unit by $20. However, when another of the basic components is purchased, a saving of $20 to $50 over the price of the usual two units required will be realized.

No tools are required to attach the Power Handle to its associated components. A single hand-operated locking device is turned to remove or attach the Power Handle. Threading the V-belt of the auxiliary component around the drive sheave on the engine then completes the installation. Among the approximately 40 components designed for future production are a wheelbarrow, electrical generator and a sprayer.



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MACHINE DESIGN
Data Sheet

Calculating Stresses

in Fixed-End Triangular Frames

SUPPORT legs on various machine parts such as tanks, gear boxes (*Fig.* 1), etc., are sometimes made in the form of triangular frames[1] with their fixed ends attached to the part and the load applied at the apex. However, formulas in *Reference* 1 are for long slender members; in their development the elastic energy due to axial force and shear was neglected, and only that energy due to bending moment was considered. As a result, when the load at the apex is in the plane of the frame, no bending moments seem to occur at the fixed ends. When members are short and have large cross-sectional areas, these bending moments may become appreciable.

Chart Solutions: The fixed-end reactions (bending moment, axial load, and shear) have been worked out by elastic energy methods for triangular frames loaded in three perpendicular directions at the apex. In Cases 1 and 2, where the load is in the plane of the frame, the elastic energy from the bending moment, axial load, and shear reactions was considered. In Case 3, where the load is normal to the plane of the frame, the energy created by bending and torsion was considered. In Case 3 there is no axial load, and the shear energy does not affect the results.

On the chart showing the formulas for Case 1, the bending stress (Mc/I) and the axial stress (N/A) have been plotted for values of θ extending from 0 to 90 degrees, as functions of the bending stress when $\theta = 90$ degrees. The full lines are for a support of length $L = 10$ inches and a circular cross-section of 1-inch diameter. For small values of θ, the axial stress is predominant, and the bending stress is negligible. For values of θ above 72 degrees, the bending stress increases rapidly and becomes equal to the value for a fixed-end beam at $\theta = 90$ degrees.

To show the effect of increasing the cross-sectional area, the curves for 10-inch length, 2-inch diameter supports are drawn. For this case, the bending stress curve crosses the axial stress curve at 61 degrees. Even for $\theta = 30$ degrees, the bending stress is appreciable. For $\theta = 90$ degrees, the Kleinlogel formula for axial stress [$S = P \sec \theta/(2A)$] would give an infinite axial stress value. For $\theta = 0$ degrees, the results would be identical. If the load in Case 1 were acting upward instead of downward, all of the fixed-end reactions would be reversed.

For Case 2*a*, the point of load application is assumed to be completely free to rotate. Here, as for Case 1, the bending stress becomes more important as the cross-sectional area is increased. In Case 2*b*, the point of load application is assumed to be restrained against rotation. In a given application, where the amount of this restraint is unknown, the bending stress at the fixed ends cannot exceed that given under Case 2*a*, while the bending stress at the point of load application cannot exceed that given under Case 2*b*.

On the charts for Cases 1 and 2, the quantity K is a factor which makes allowance for the fact the shearing stress is not uniformly distributed across the section. For sections other than circular or square, it is rather difficult to determine. Since in the equations for T the term KE/G is usually small compared with the term $AL^2/(12I)$, no appreciable error will result if K is made equal to one.

For Case 3, the chart shows results when the point of load application is free to rotate. Curves show the bending stress (M_1r/I) and torsional shear stress (M_2r/J) as a function of the bending stress for $\theta = 0$ degrees, for values of θ extending from 0 to 90 degrees. This was done for a circular section, for which B is the polar moment of inertia. The curves show that for this case, the torsional

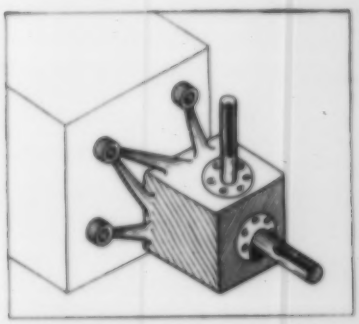


Fig. 1—Gear box supported by fixed-end triangular frames

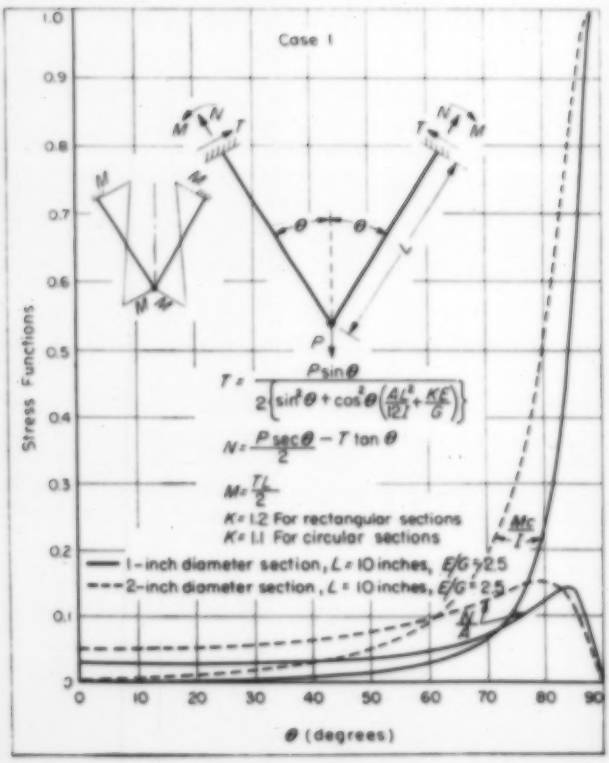
1. A. Kleinlogel—*Rahmenformeln*, Eleventh Edition. F. Ungar Publishing Co., New York, 1952. Pages 70 and 71.

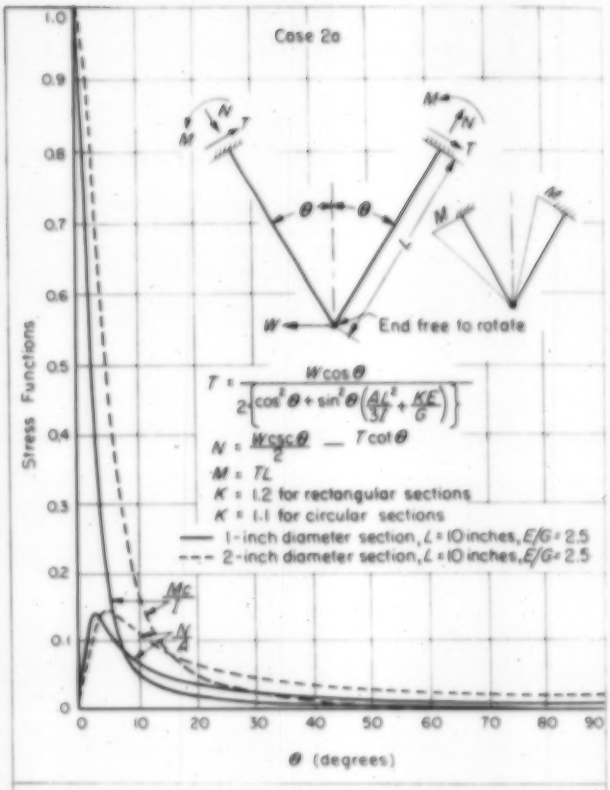
shear stress is small compared with the bending stress. For a square section, $B = 0.141\ b^4$ where b is the length of side. In general, $B = M_2L/(G\phi)$ where M_2 is the torque, L is the length of the member, G is the shear modulus of elasticity, and ϕ the angle of twist in radians.

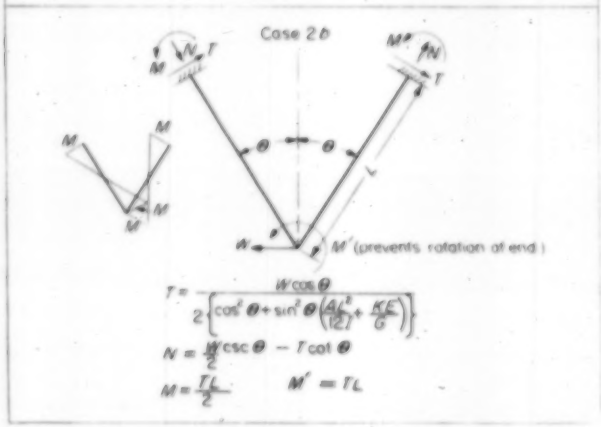
If, in Case 3, the point of load application is restrained against rotation, $M_1 = QL/r$ for all values of θ, and $M_2 = 0$, showing there is no torsion.

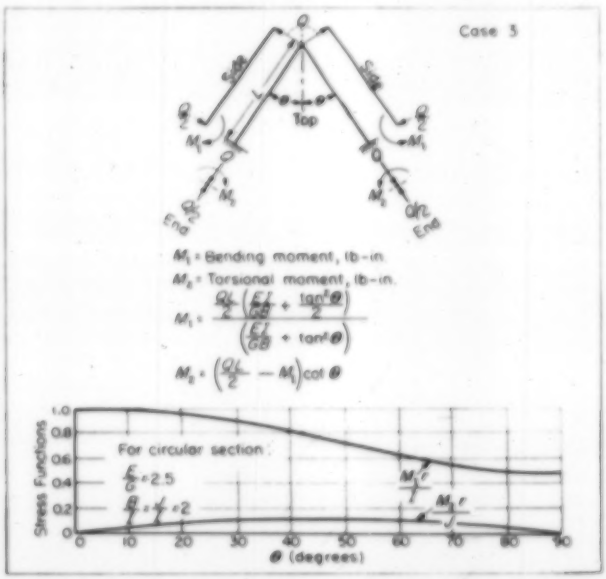
Nomenclature

- A = Cross-sectional area of each support rod, sq. in.
- B = Torsional stiffness = polar moment of inertia for a circular section, in.^{4}
- b = Width of sides of a square bar, in.
- c = Distance from neutral axis to extreme fiber, in.
- E = Modulus of elasticity, psi
- G = Shear modulus of elasticity, psi
- I = Moment of inertia of section, in.^{4}
- J = Polar moment of inertia of circular section, in.^{4}
- K = Constant which allows for nonuniform distribution of shearing stress
- L = Length of support leg, in.
- M = Moment, lb-in.
- N = Normal reaction load, lb
- P = Loading along line of symmetry, lb
- Q = Loading (Case 3), lb
- r = Radius of rod support leg, in.
- S = Axial stress, psi
- T = Transverse (shear) reaction load, lb
- W = Loading perpendicular to line of symmetry, lb
- θ = Angle between support leg and a vertical centerline, deg
- ϕ = Angle of twist, radians


Case 1
Stress Functions
θ (degrees)
$T = \frac{P\sin\theta}{2\left\{\sin^2\theta + \cos^2\theta\left(\frac{AL^2}{12I} + \frac{KE}{G}\right)\right\}}$
$N = \frac{P\sec\theta}{2} - T\tan\theta$
$M = \frac{TL}{2}$
K = 1.2 For rectangular sections
K = 1.1 For circular sections
1-inch diameter section, L = 10 inches, E/G = 2.5
2-inch diameter section, L = 10 inches, E/G = 2.5
Mc/I
N/A


Case 2a
Stress Functions
θ (degrees)
End free to rotate
$T = \frac{W\cos\theta}{2\left\{\cos^2\theta + \sin^2\theta\left(\frac{AL^2}{12I} + \frac{KE}{G}\right)\right\}}$
$N = \frac{W\csc\theta}{2} - T\cot\theta$
M = TL
K = 1.2 for rectangular sections
K = 1.1 for circular sections
1-inch diameter section, L = 10 inches, E/G = 2.5
2-inch diameter section, L = 10 inches, E/G = 2.5
Mc/I
N/A


Case 2b
M' (prevents rotation at end)
$T = \frac{W\cos\theta}{2\left\{\cos^2\theta + \sin^2\theta\left(\frac{AL^2}{12I} + \frac{KE}{G}\right)\right\}}$
$N = \frac{W\csc\theta}{2} - T\cot\theta$
$M = \frac{TL}{2}$
$M' = TL$



DESIGN ABSTRACTS

Selecting reduced-voltage methods for

Motor Starting

By H. W. Cory and T. F. Bellinger

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REDUCED-voltage motor starters are used when the distribution system cannot maintain its voltage during the motor-starting inrush or when the driven load cannot stand the shock of a sudden start. Such loads as conveyors, elevators, hoists, feeders, and certain machine tools frequently fall into the latter group.

Since today's standard ac motors are designed for full-voltage starting, they should always be started on full voltage when line and load conditions allow. Full-voltage starters are simple and economical, and have no size limitation. They are provided with one of three basic control schemes, *Fig.* 1. Selection is based on application and power distribution system requirements.

The most important factor influencing motor starting is the stability of the power system on which the motors operate. When polyphase ac motors, either the squirrel-cage induction or synchronous types, are started on full voltage, the current required to

Table 1—NEMA Motor Characteristics

NEMA Code Letter	Synchronous Speed (rpm)	Power Range (hp)	Torque (per cent of full-load) Locked-Rotor	Torque (per cent of full-load) Breakdown	Slip	Locked-Rotor Current (per cent of full-load)	Application
A	3600	1½-200	175-100	Values in	Less than	.....	High breakdown torque
	1800	1-200	275-100	excess of	5 per cent	.....	and high locked-rotor
	1200	¾-200	175-125	those for		.....	current
	900	½-200	150-125	Design B		.....	
	720	½-200	150-120			.....	
	600	½-200	115			.....	
	514	½-200	110			.....	
	450	½-200	105			.....	
B	3600	1½-200	175-100	275-200	Less than	.....	Characteristics suitable
	1800	1-200	275-100	300-200	5 per cent	820-630	for most applications
	1200	¾-200	175-125	275-200		720-622	
	900	½-200	150-125	250-200		603-591	
	720	½-200	150-120	200		.....	
	600	½-200	115	200		.....	
	514	½-200	110	200		.....	
	450	½-200	105	200		.....	
C	1800	5-200	250-200	200-190	Less than	820-630	Applications requiring
	1200	3-200	250-200	225-190	5 per cent	720-622	high initial torque to
	900	3-200	250-200	200-190		603-591	start
D	1800	½-200	275	275	5 per cent	820-630	High torque and high
	1200	½-200	275	275	or more	720-622	slip, for high inertia
	900	½-200	275	275		603-591	loads
F	1800	30-200	125	135	Less than	.....	Low locked-rotor cur-
	1200	30-200	125	135	5 per cent	.....	rent and torque

break away and accelerate the motor is several times full-load current, diminishing as the motor gains speed.

Squirrel-cage motors are designed according to NEMA "letter designations" which describe the motor. Five NEMA categories and their corresponding characteristics are listed in *Table* 1. Motor locked-rotor current has no direct relationship to motor torques, and the values of locked-rotor currents must be obtained from standard tables or directly from the motor manufacturer. If the actual value of the motor-starting current cannot be obtained, an average value of 600 per cent is usually assumed for squirrel-cage and synchronous motors. This value is usually close enough for use in applying standard equipment.

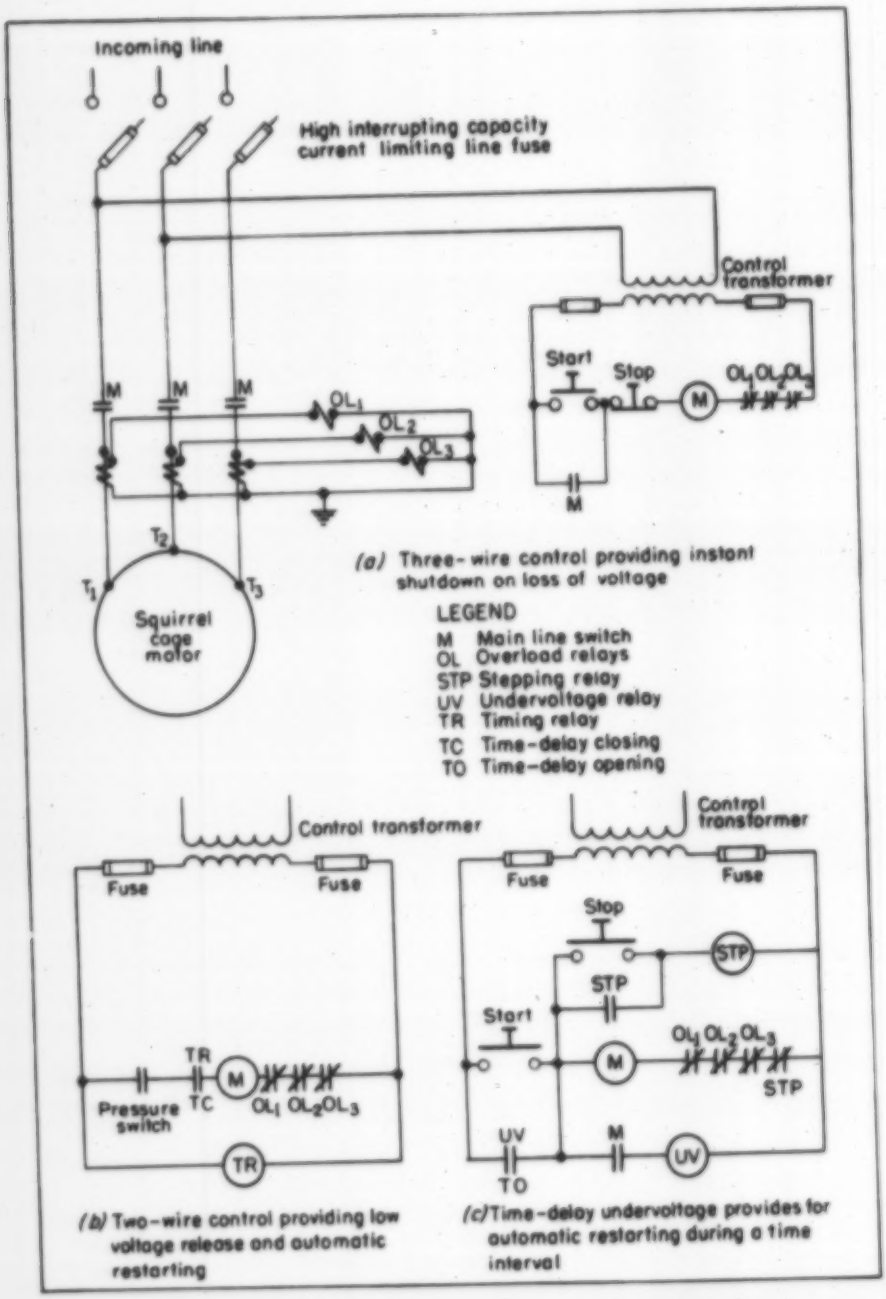

Fig. 1—Diagram of a full-voltage starter and three basic control schemes

System Stability Upset: The starting of motors on full voltage can produce harmful effects if sufficient reserve kva is not available from the power system. The effects on the power system usually result in dips in line voltage. This may be produced by exceeding the feeder transformer capacity, excessive line loss, or a combination of both. In addition, starting currents can cause the system protective devices to open and interrupt service completely.

A dip in line voltage greatly affects the equipment connected to the system. Voltage dips of sufficient magnitude can cause synchronous motors to pull out of step, release holding circuits in motor starters and stop their motors, produce serious overheating to motors, and damage the motor controllers. Motor overheating is produced because of the longer accelerating time during which the motor winding must carry starting current, and because of higher running currents with motors running at greater per cents of slip.

Motor starters are magnetically held in the running position and may drop out to stop the motor if the line voltage should drop sufficiently. Motor controllers will usually open at approximately 70 per cent of normal voltage or below. Such shutdowns often prove costly and should be avoided whenever possible.

Minimum operating voltage permitted by the manufacturer's guarantee of motors is 10 per cent less than rated nameplate voltage. Load characteristics of the motors cannot be obtained if the operating line voltage should fall below this point. Minimum voltage permitted for the operation of motor controllers is 15 per cent below the nameplate rating. The 15 per cent minimum should not be exceeded during the acceleration or during normal operation of motors.

Reduced Starting Current: There are several methods of reducing starting kva in squirrel-cage and synchronous motors. Types of starters in the order of their importance are: autotransformer, resistor, reactor, part-winding and wye-delta.

Where extremely high motor

Table 2—Autotransformer and Reactor Design Classifications

Service Classification	Rating of Motors (hp)	Starting Taps for 25 and 60 Cycles (approx per cent of line voltage)
Heavy duty	All ratings	Taps determined by application
Medium duty	50 hp and less	65-80
	Above 50 hp	50-65-80
Light duty	All ratings	30-37.5-45

torque is required to break away a heavy machine load, the starting kva can be reduced through the use of a wound-rotor motor. These motors have the additional advantage of high starting torque.

Autotransformer Starting: Where a reduction of the starting kva is required, autotransformer-type controllers are the most common choice.

A typical circuit for a low-voltage autotransformer squirrel-cage controller is shown in *Fig.* 2. These controllers are available in ratings up to several hundred horsepower for both the low and high-voltage classes. The autotransformers have intermittent ratings for light, medium or heavy-duty applications and have voltage taps in these duty classes, *Table* 2. Either two or three-leg starting autotransformers are used in three-phase controllers. The diagram of a two-leg type, commonly used in standard motor controllers, is shown in *Fig.* 2. This type of circuit causes about 15 per cent higher voltage unbalance on terminal T_2 than appears on T_1 and T_3 while the unit is supplying reduced voltage to the motor terminals. Except in very special applications, this unbalance is not a problem. Since the two-leg units are less expensive, they are most widely used.

Current taken from the line to start polyphase motors is reduced by reducing voltage to the motor terminals while the motor accelerates to a definite speed or current point. Voltage reduction is accomplished in these motor controllers by connecting the motor to the line through an autotransformer, as shown in the diagram. The voltage on the motor terminals during starting is set by the tap connections made to the autotransformer. Most controllers are equipped with medium-duty units and are connected at the factory to the 65 per cent taps. The controller will automatically disconnect the autotransformer from the circuit and connect the motor directly to the line. Definite time relays or current relays control the transfer from start to run.

When starting a motor with an autotransformer - type controller, the minimum voltage tap that will adequately accelerate the motor and its connected load is used. The motor should reach its maximum speed before it is transferred to full voltage. Correct transfer timing minimizes the line disturbance and reduces arcing on the controller line switches. When the controller transfers to full voltage, the circuit to the motor is completely interrupted and reconnected. If the motor has not accelerated sufficiently, the current at transfer to full voltage can be much greater than the current taken from the line at the instant of starting and can be nearly as much as full-voltage locked-rotor current.

The autotransformer voltage tap and the transfer point are selected to obtain a current at transfer that does not exceed zero-speed current. If this current is exceeded, the advantages of reduced-current starting are lost. The proper autotransformer tap and transfer setting are usually selected by trial.

Autotransformer starting is called "open transition starting" because of the open circuit condition during transfer to full voltage. The open circuit condition is the main disadvantage to this method of starting. A three-leg autotransformer circuit can be used to overcome this disadvantage. However, starters with this circuit are special and therefore expensive.

The autotransformer method of starting provides greater starting torque per ampere than any other type of reduced-current starting. Current taken from the line in per cent of full-voltage starting current, equals $V^2/100$, where V = starting voltage, per cent of full voltage. Thus, when the 50 per cent tap is used, only 25 per cent of the full-voltage starting current is taken from the line, while the 80 per cent tap will allow 64 per cent of the full-voltage starting current. The magnetizing current of autotransformers is about 5 to 10 per cent of total line current and must be added to the value of the line current if accurate calculations are required.

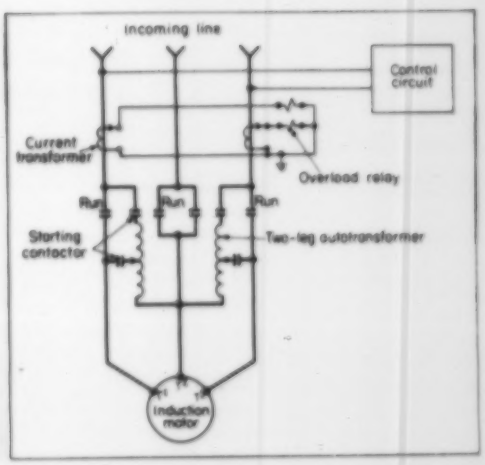

Fig. 2—Diagram of an autotransformer - type cage motor controller with voltage taps at 50, 65 and 80 per cent of full load

Primary Reactor and Resistor Starting: Another method used to reduce starting current consists of placing a reactor or resistor element in series with each phase of the motor to reduce the voltage on the motor terminals. The elements remain connected until the motor has accelerated sufficiently so that transfer to full voltage can occur with minimum line disturbance. Transfer can be accomplished either with time-delay relays or with current relays similar to the autotransformer-type controllers. After transfer has been completed, the starting elements are either disconnected from the circuit or shorted out during normal operation. The transfer from reduced voltage to full voltage occurs without any interruption in the power connection to the motor. These controllers are referred to as "closed transition starting units" because of this characteristic.

Starting reactors have intermittent ratings according to duty requirements, *Table* 2. Resistor-type starters are somewhat less expensive than the reactor type but are available only in low-voltage ratings in sizes up to motors having full-load currents under 600 amp. For higher voltages or currents, insulation, space factors and power losses make the use of primary resistors impractical.

Reactor and resistor starting do not limit starting current to the same extent as autotransformer starting. Starting currents with reactor or resistor types are directly proportional to voltage at the taps. A 50 per cent reactor or resistor voltage tap limits the starting current to 50 per cent of the full-voltage value, whereas the 50 per cent autotransformer tap limits the current to only 25 per cent of the full-voltage value. However, the closed transition feature can be of great importance on systems equipped with voltage regulation. Even though the current at transfer may be greater than starting current, the rise in current is only an addition to the starting current, and not from zero as it was for the autotransformer starting. Both reactor and resistor methods permit balanced currents for motor starting.

Most standard reactor and resistor starters are designed for two-step starting—one step on reduced voltage and the final step to full voltage. A high-voltage primary reactor starter is shown in *Fig.* 3. Both reactor and resistor controllers are readily available with more than two starting steps. The current change per step decreases proportionally with the number of steps used.

A primary resistor starter is less expensive than another type of comparable starter when both are available in the same ratings. The reactor type is more efficient and will produce slightly more starting torque.

A comparison of the three most common types of reduced-voltage starters is shown in *Table* 3.

Part-Winding Starting: The stator windings of most integral-horsepower ac motors are made with two or more conductors in parallel per phase. The conductors are normally tied together inside the machine and only single-phase terminal leads are brought out. It is possible to bring each individual phase conductor out to terminals and make the parallel connection for each phase external to the motor. If a single conductor of each phase were connected to line voltage, only a portion of normal starting current would flow. If there were two conductors per phase, each would carry half of the motor current. If one set of conductors were connected, the starting cur-

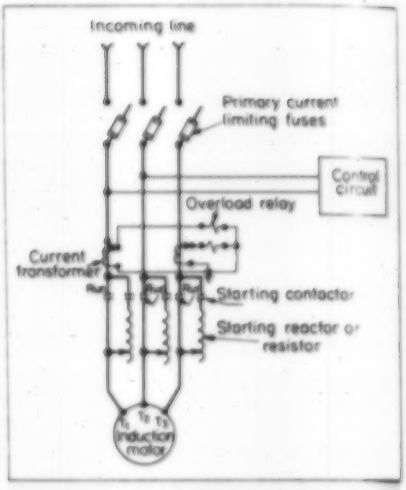

Fig. 3—Diagram for a primary reactor-type cage motor controller. The controller is for high-voltage motors and provides 150,000 kva interrupting capacity at 2300 volts or 250,000 kva at 4600 volts

Table 3—Starting Conditions for Three Reduced-Voltage Starters

Characteristic	Autotransformer Type	Primary Resistor Type	Reactor Type
Starting line current at same motor terminal voltage	Least	More than autotransformer type	
Starting power factor	Low	High	Low
Quantity of power drawn from line during starting	Less	More than autotransformer type	
Torque	Increases slightly with speed	Increases greatly with speed	
Torque efficiency (per amp)	High	Low	Low
Acceleration smoothness	Momentary disconnect during transfer from start to run	Smoother; current decreases as speed increases; voltage drop across resistor or reactor decreases; motor terminal voltage increases; no disconnect	
Cost	Equal	Lower in small sizes; otherwise equal	Equal
Ease of control, maintenance, safety and reliability	Equal	Equal	Equal
Line disturbance	Varies with line conditions and type of load		

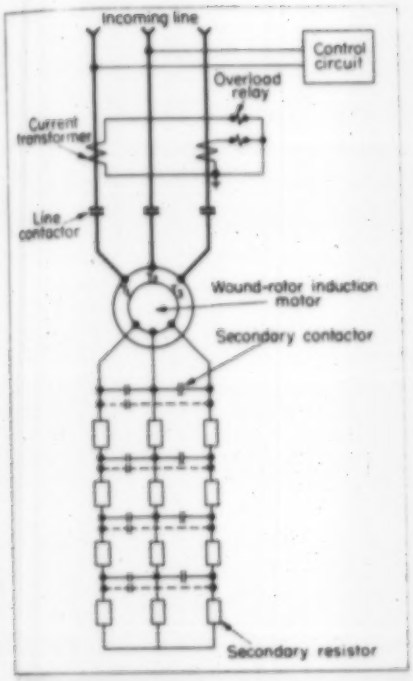

Fig. 4—Diagram for an automatic wound-rotor controller. The controller provides five-step starting but does not regulate speed

rent would be just half that of a standard motor. The current for each set of conductors per phase is inversely proportional to the number of conductors per phase.

Part-winding motors are usually started by connecting each set of phase conductors to the line in sequence until all conductors for each phase are in parallel, after which the motor will be ready for normal operation. The sequence is usually controlled by timing relays set for short time intervals of 1 to 5 seconds. The purpose of part-winding starting is not to provide reduced current for acceleration of the motor but primarily to provide smaller increments of starting current. The phase conductors are not capable of carrying current individually for more than a few seconds. Often on three-step starting the first step interval is set for a second or less. The motors usually do not break away under these conditions, but the purpose of reducing the magnitude of the starting current into a series of small increments has been achieved.

Part-winding starting is not widely used. There are some sizes of low-voltage motors and controllers available, but high-voltage units are seldom used except in some phases of the cement industry. Controllers for use with part-winding motors are lower priced than similar controllers of the auto-transformer, reactor, or resistor types because current-limiting elements are not required.

Wye-Delta Starting: In a method frequently used in Europe and South America, ac motors are started by connecting the motors to the line with the stator windings connected in wye. After the motors have accelerated to their maximum speed, the windings are reconnected in delta for normal operation. This permits the locked-rotor current to be reduced by a factor of $1/(3)^{1/2}$, or 57½ per cent of normal locked-rotor current. This type of starting is open transition and does not offer much advantage, since only a 57½ per cent starting point is possible. Both ends of each motor phase winding, or a total of six terminals, must be brought out. This arrangement is costly and is not standard in this country. Wye-delta starting is not recommended for general application.

Wound-Rotor Motors: All of the starting methods previously covered were for the starting of either squirrel-cage induction motors or synchronous motors. Wound-rotor induction motors are used to obtain smooth starting and acceleration to protect the driven equipment or power systems and to obtain speed control.

Although wound-rotor motors are started directly across the line, motor controllers can cause them to accelerate smoothly and efficiently, with initial starting currents less than that required for other types of motors. The rotor, or secondary slip rings, are connected to banks of definite values of resistance for each of the secondary phases.

A diagram of a typical automatic controller for a wound-rotor motor is shown in *Fig.* 4. These motors are started with the total resistance in the circuit. By shorting out specific sections of the secondary resistance in sequence, the motors accelerate through a series of definite speed-torque characteristic points corresponding to the number of resistance steps and the value of the resistance at each step. The number of steps, or speed points, is always one greater than the number of shorting switches. Secondary characteristics and control components can be identical for similar motors of equal horsepower rating even though stator voltage ratings may be widely different.

Number of resistance steps can be increased or decreased depending upon the application. If smoothness of starting is to be improved, a greater number of steps are used. Stepless starting can be obtained by the use of liquid rheostats in place of secondary resistors and the shorting switches. This type of controller is comparatively expensive and is used only for special applications.

Starting current of wound-rotor motors can be limited to specific values by the design of the secondary resistor banks. Duty cycle of the application determines the thermal capacity that must be built into the resistors. Lower inrush currents or a more severe duty cycle increases both size and cost of the secondary resistor banks. If speed regulation of the wound-rotor motor is required, the resistors must be designed for continuous duty for the step where speed control is desired. Regulating duty resistors are designed for a fully loaded motor. If the motor does not draw full-load power, the specified degree of speed regulation cannot be obtained without additional resistance.

Wound-rotor motors and their controllers are more expensive than cage units, but their use should be considered when severe starting problems are anticipated. The wound-rotor motors and control permit flexible speed adjustment and reduce starting-current increments.

From "Motor Starting—A Distribution System Problem" in Allis-Chalmers Electrical Review, *First and Second Quarter*, 1955.

Designing for

Noise Reduction in Rotating Machines

By J. M. Shulman
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CONTINUOUS loud noise is detrimental and in severe cases is thought to be unsafe. Much work is being done to establish more definite standards for noise in terms of human comfort and safety. In the meantime, low noise level in electrical machines has become a sought-after performance characteristic. For operation in relatively quiet places it is not uncommon for a maximum noise level to be stated in machine specifications. Moreover, these maximum noise levels in some cases are lower than those considered satisfactory a few years ago.

Two basic approaches to the problem of noise reduction in electrical machines are: reducing the generated noise level and dissipating as much of the generated level as possible before it gets outside the machine. Internal dissipation of noise is accomplished by lining as large a portion of the interior surfaces of the machine as practicable with sound-absorbing materials. Inherently this method is applicable to large machines. For machines of integral horsepower sizes and smaller, external deadening of noise is often effective.

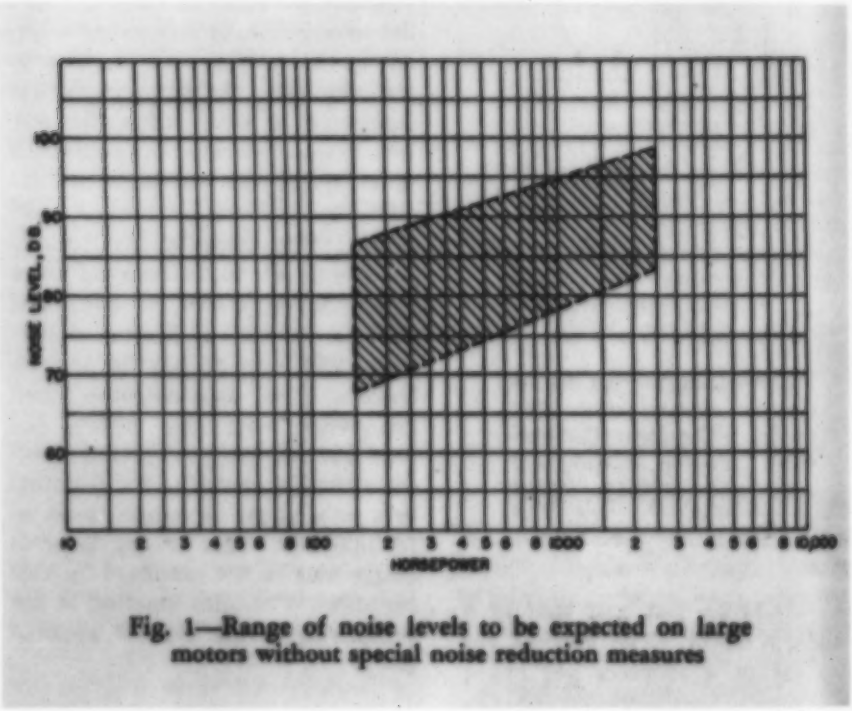

Fig. 1—Range of noise levels to be expected on large motors without special noise reduction measures

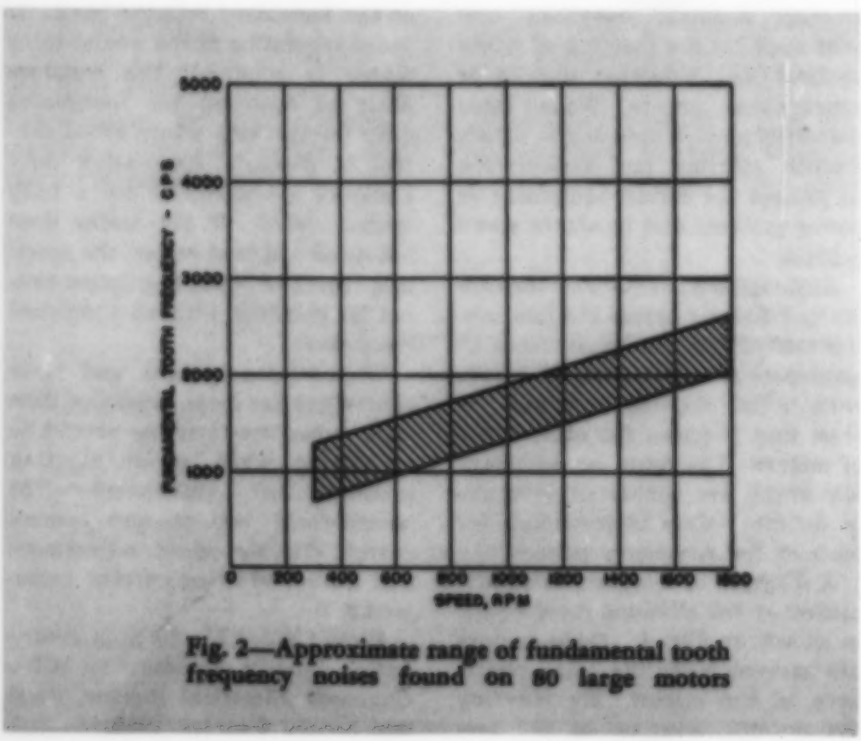

Fig. 2—Approximate range of fundamental tooth frequency noises found on 80 large motors

Noise Sources: In reducing noise by internally-applied sound-absorbing materials, it is helpful to know what measures are required. Results of 160 noise tests on motors from 150 to 2500 horsepower are shown in *Fig.* 1. These machines are representative of good design practice in having employed all economically feasible measures for the reduction of generated noise. The

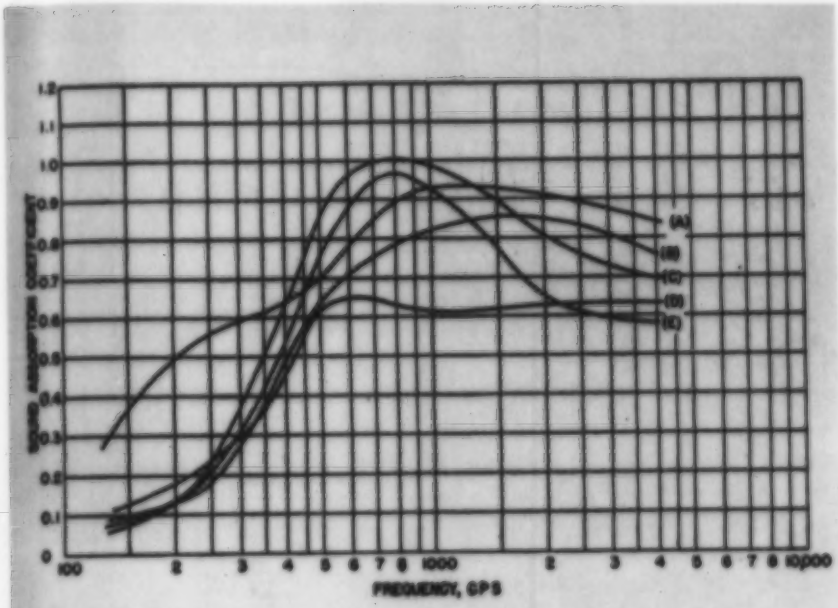

Fig. 3—Sound absorption coefficients of some of the materials suitable for internal application on machines: *A*, Fiberglas flexible duct liner 1 inch thick; *B*, Acousti-Celotex perforated mineral tile ⅜-inch thick; *C*, Acousti-Celotex perforated mineral tile 1 inch thick; *D*, Acouti-Celotex cane fiber tile ½-inch thick; *E*, Acousti-Celotex ¾-inch cane fiber tile

range of ordinates within the block covers different enclosures tested and speed from 3600 rpm down to approximately 360 rpm.

Of all the frequencies composing the generated noise of electrical machines the tooth frequency components are usually the most troublesome, whether caused electrically or mechanically. The whir of air through an open machine or through ducts is usually not objectionable, but electrical slot whine or the siren effect of air in slots or near rotor bars almost always has a damaging effect on persons nearby. Approximate range of tooth frequencies for machines of 150 to 2500 horsepower appear in *Fig.* 2. Many of these are in the most troublesome region from the standpoint of ear response, the range in which noise meter readings are most heavily weighted.

Noise Absorption: To line the interior surfaces of a machine it is convenient to use flexible material on curved surfaces. Perforated acoustic tile can be mounted on flat surfaces or surfaces with large radii. Nonflammable materials should be used in all electrical machines. Sound-absorption coefficients as a function of frequency are shown in *Fig.* 3 for some of the materials suitable for this purpose. Using the data of *Fig.* 3, it is possible to estimate the noise reduction which can be realized at a certain frequency by applying these materials to a given area of internal machine surface from the equation

$$\text{Decibels} = 10 \log \left\{ A_1K_1 + A_2K_2 + \ldots + A_nK_n + [A - (A_1 + A_2 + \ldots + A_n)]\, K_s \right\} - 10 \log (AK_s)$$

where A is the total interior machine surface, K_s is the sound-absorption coefficient of the machine surface before lining, and A_1, A_2 . . . A_n are areas of surfaces lined with materials having sound-absorption coefficients K_1, K_2 . . . K_n.

A typical application in which noise of a large induction motor was reduced by the application of sound-absorbing materials internally on the frame only is illustrated by *Fig.* 4. Interior of the frame and frame cover were lined with Fiberglas flexible duct liner, 1 inch thick, held by bolts with wide washers engaging tapped holes in the frame. Air-directing baffles at the air outlets on each side and the feet of the motor were used as mounting plates for pieces of 1-inch thick asbestos perforated acoustic tile. This motor before treatment had a noise level of 87 decibels, predominantly due to a slot windage component at approximately 2000 cycles. With eight acoustic tile surfaces and the flexible duct liner, the noise level was reduced to 79 decibels.

On machines where blower noise

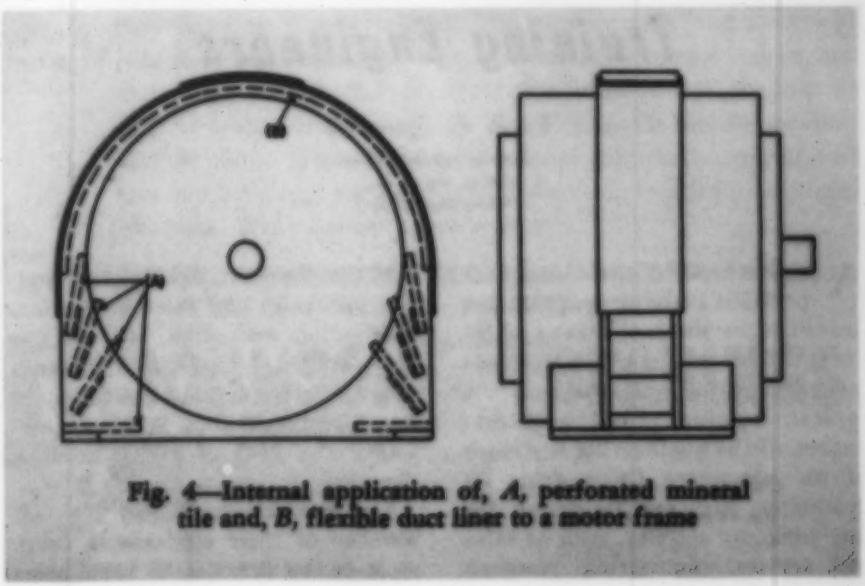

Fig. 4—Internal application of, *A*, perforated mineral tile and, *B*, flexible duct liner to a motor frame

is excessive, *Fig.* 5 illustrates a method by which this noise has been effectively reduced. Flexible duct liner is cut into segments and mounted on the cone portions of the airshields. Perforated acoustic tile is cut into segments and mounted on the ring portions of the airshields. The end cylinders are lined all around with flexible duct liner.

Installations where air inlets or outlets on a machine are ducted sometimes require that machine noise be kept out of the ducts. In these cases it is practicable to make sound absorbing boxes at the inlet and outlet ducts in addition to lining interior surfaces of the machine, *Fig.* 6. Here the sound-absorbing boxes were formed by placing perforated acoustic tile baffles parallel to the direction of air flow, the objective being to obtain the maximum area of sound absorbing material possible within the limiting dimensions of the boxes.

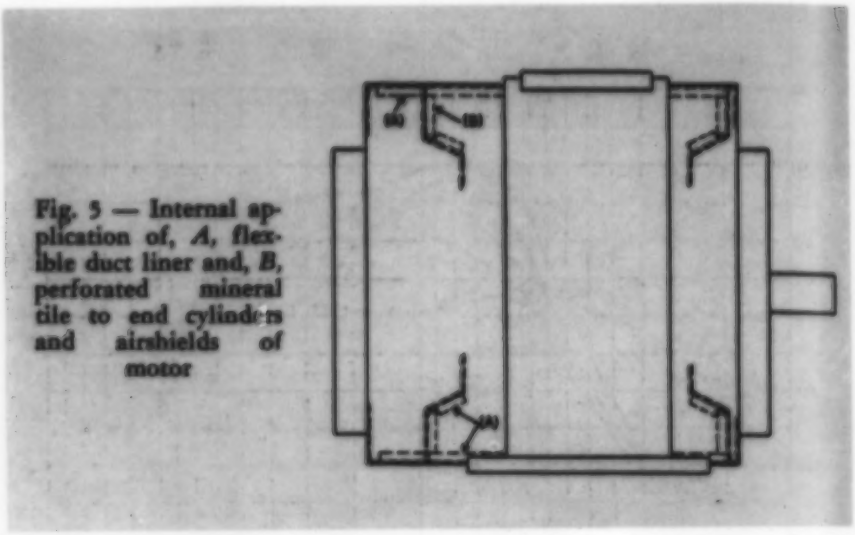

Fig. 5 — Internal application of, *A*, flexible duct liner and, *B*, perforated mineral tile to end cylinders and airshields of motor

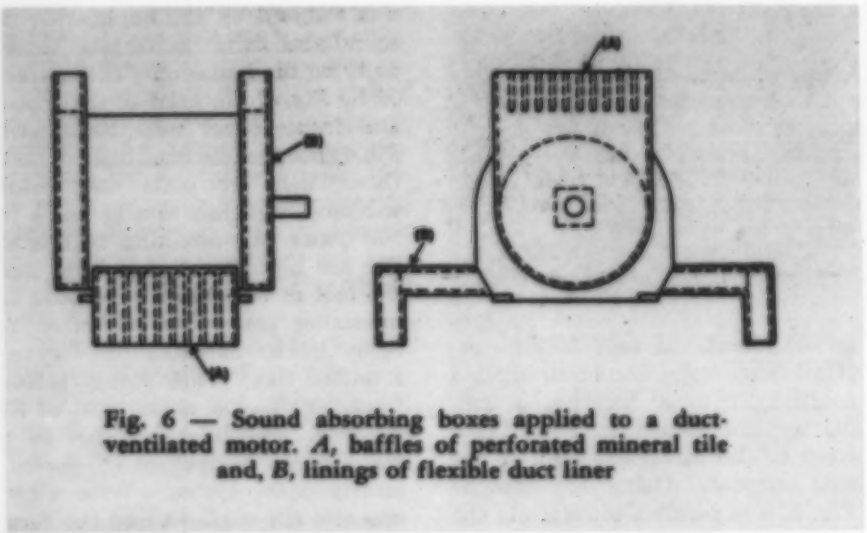

Fig. 6 — Sound absorbing boxes applied to a duct-ventilated motor. *A*, baffles of perforated mineral tile and, *B*, linings of flexible duct liner

From a paper entitled "Noise Reduction in Large Rotating Machines" presented at the AIEE Winter General Meeting in New York, N. Y., February, 1955.

Developing a plan for

Training Engineers

By R. E. Sprenkle

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A well-organized and closely supervised training program has proved to be the best means of indoctrinating college graduates into most industrial organizations. A typical training program encompasses all the engineering activities of the company. Thus, from its graduates, men can be drawn for any company activity, such as sales and service, engineering, research and development, application engineering, sales and sales promotion, production, education, etc. In due time many of these men advance into administrative positions of great responsibility, which is certainly the goal of every training program.

Colleges graduate the greatest number of their students in June, so it is the practice to beam most recruiting programs toward June graduates. In this manner there will be a sufficiently large group of trainees available to start classroom work early in the summer. An added feature of forming such class groups for indoctrination and lecture periods is that it helps formulate a certain esprit de corps and comradeship which often are as valuable as the technical training itself.

To accommodate these classes it is highly desirable to provide a lecture room or small auditorium apart from the factory and office to prevent interference and distraction, and to permit proper concentration. Desks or tables should be provided as well as visual aid equipment, such as blackboards, projection equipment for slides and

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movies, operating and cutaway models of company products. The student should be given outlines of the lectures, including all illustrations, prints and charts, for his permanent file, and of course he should be provided also with bulletins, instructions and other company material which will assist him in gaining complete knowledge of the product and its application.

The length of course will depend upon requirements, but in general it appears no less than 3 months is necessary, and it may require up to a year or more to do the job needed. The length of Bailey Meter's training course at the home plant is about 9 months, which is supplemented by additional field work in servicing the equipment on the job, or other activities in the main office and plant.

Typical Training Program: An outline of a typical industrial training course is given in *Table* 1. Most of the lectures are given during the first hour or two of the day, and the trainee then spends the remainder of the day in his shop or office assignment. Each of these assignments lasts from 1 to 4 weeks, at the conclusion of which the trainee is moved to another department, this process continuing until he has worked in all the departments listed in the outline.

Records are kept of the trainee's performance, both in the factory and classroom. At the conclusion of the assignment in each department, the foreman submits a report which evaluates the trainee's mental and mechanical ability, his interest in the work, dependability, co-operativeness, initiative, and deportment. Examinations are given at least twice a month covering the classroom lecture material. Conferences are held frequently with the trainee as to his progress in the course and to guide his thinking toward the selection of the kind of work he wants to follow upon its completion.

While this course has not changed in principle since its inception in 1919, it has been modified in detail from year to year as new products and new instrumentation and control techniques have been developed. As a result, the trainee now has access to a far greater diversity of work experience in the shop and in the technical departments than was available in the beginning.

Training Program Objectives: If this experience can be used as an index, training programs for college graduates should provide the following:

1. A general orientation period in which company policies, organization, operational procedures, departmental or divisional functions, the company's outlook, career opportunities and like matters are discussed by top executives. Opportunity also should be given to class members to meet these executives during this period.

2. Assignment of all students on a rotative basis to all departments or divisions of the organization where, under close supervision, they will help build the equipment or products made in each department. Nothing can take the place of, or excel, this part of the training program.

3. Sufficient time in the engineering, design, research and development, production, planning and/or other technical departments to learn at least the fundamentals of these activities in the organization, and just how they all dovetail together.

4. Classroom lectures and discussions covering basic technical fundamentals as applying to products or services, the products themselves and their application to industry. Preferably, these should be given by as large a staff as possible so as to utilize the best talent available, give the student the opportunity of learning who the key people are in the organization, and add variety to the presentation. Examinations should be given frequently and graded so as to judge the student's aptitudes and his ability to grasp what is being presented to him.

5. Opportunity for the student to select the kind of work in which he is most interested after the formal training program is completed. Most college graduates do not know what they want to do when they leave college. Thus, the chance of trying their hand at a lot of different activities during the training program helps them to make the proper decision.

6. After the formal training course has been finished and the actual job assignment has been made, there should be additional on-the-job training. Here the young engineer should work with experienced men who can direct his work along the desired lines. The student should be able then, within a relatively short time, to take over a job assignment on his own, or at least be capable of assuming minor responsibilities and supervision of other new men who have just finished the training course.

Additional Opportunities: Every young engineer should continue his education by study, reading technical magazines and papers, and taking advanced courses in night school classes or by correspondence. He also should be encouraged to take the examination for profes-

Table 1—Outline of Typical Engineering Training Course*

Lecture Schedule

1. Orientation and indoctrination
2. Fundamentals and theory of fluid flow
3. Primary elements for fluid flow
4. Mechanically operated flow meters
5. Engineering and sales department procedures
6. Principles of combustion; boiler meter
7. Electrical instruments
8. Major steam generating equipment
9. Fundamentals and components of automatic control
10. Steam boiler and auxiliary controls
11. Process controls
12. Field adjustments and control tune-up
13. Selling equipment
14. General (patents, branch office procedures, etc.)

Work Assignments Schedule

1. Factory
   - a. Meter calibration department
   - b. Light assembly department
   - c. Relays and selectors department
   - d. Gages department
   - e. Pneumatic transmitters
   - f. Electrical department
   - g. Research and development
   - h. Control drive department
   - i. Control valve department
   - j. Hydraulic laboratory
   - k. Panel board department
2. Office
   - a. Contract engineering department
   - b. Proposition department
   - c. Design department
3. General instrumentation course
4. Clean-up

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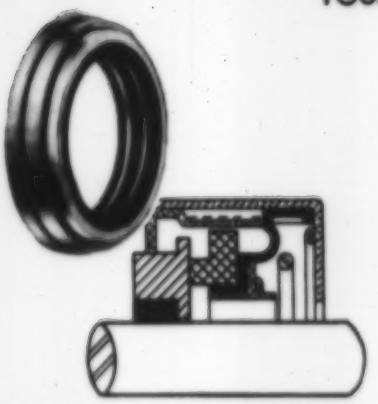
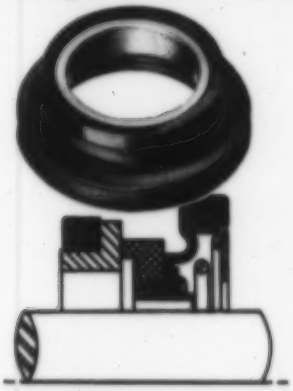
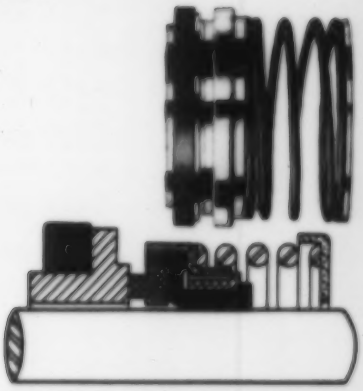


STYLE GU — A packaged sealing unit containing both rotating and stationary seal faces enclosed in metal housing. Important applications in machine tools and power transmission equipment. Stock sizes for shafts .250 through 4.000.

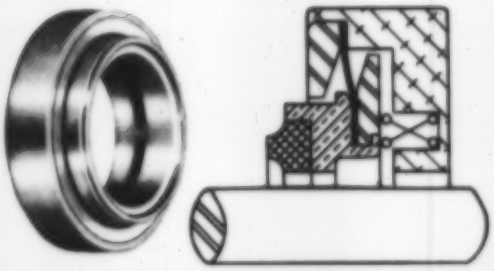


STYLE SGU—A factory-assembled unit-type seal for the small budget user. Widely used in appliance field. Stock sizes for shafts .250 through 1.000.

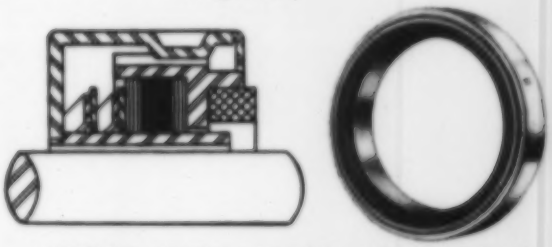


ROTO-FLEX — Rugged flexibility. Only 3 parts. Single or double units. Many applications in pumps and compressors. Stock sizes for shafts .250 through 4.000.

STYLE RFO—A specially designed Roto-flex seal, for installation outside the stuffing box. Stock sizes for shafts .250 through 4.000.



STYLE DPC — A high-speed, carbon-faced seal, for use where lubrication is poor or where shaft RPM and resulting friction are high. Ideal in many machine tool applications. Stock sizes for shafts .250 through 4.000.



STYLE HH—Absolute minimal space (both radial and axial) under extreme conditions of temperature, pressure and seal face surface speed. Features pressure balance when fluid pressure is applied internally or externally. Of particular importance to the aircraft industry. Stock sizes for shafts .250 through 4.000.

These are only a few of the countless sealing problems now being solved by

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sional engineer's license, as well as to join national engineering societies, and to participate actively in society affairs. He will find the association with other engineers in such societies most rewarding and stimulating and well worth the time and effort he puts into it. Through refresher courses and informative literature the young engineer can be kept up to date on his company's activities.

From a paper entitled "Recruiting and Training Engineering Graduates for Industry" presented at the ASME Management Division Conference in Cleveland, O., March, 1955.

Dimensional Control of

Investment Castings

By Edwin G. Chapman

Misco Precision Casting Co.
Whitehall, Mich.

ONE of the prime advantages of the investment casting process has been the production of close-tolerance, dimensionally controlled castings. This dimensional control advantage created considerable interest to potential consumers in general at the inception of its development. Tremendous enthusiasm which ensued in the investment casting business ultimately did the industry considerable harm.

Early claims of dimensional tolerances of ± 0.001-inch per linear inch and cast finishes of 10-25 RMS were commonly made and were accepted by American industry as authentic.

More and more parts came off the drawing boards with tolerances based on the initial claims of the investment casting industry, and as these parts were run in production quantities, enthusiasm gave way to the cold realization that the process had been oversold. The ± 0.001 tolerance could not be held except by selective inspection and this would, of course, directly reflect itself in casting prices. A 10-25 RMS surface finish could be achieved only with expensive polishing operations which were not representative of the process.

An appraisal of more realistic benefits of investment casting should begin with consideration of the master pattern.

The Master Pattern: Basically, all dimensional control must start with the master pattern itself. Proper incorporation of shrink allowances is of the utmost importance, particularly in larger patterns. Once the shrink factor has been positively established, a projected master pattern must be studied to determine any unusual features that might tend to vary the normal shrinkage factors:

1. *Heavy sections in a part which produce localized shrink or cavitation in the wax pattern that is unacceptable:* In these cases, it is necessary either to core or "chill" the section to reduce the shrinkage. Since the incorporation of a core or chill will greatly change the volumetric and linear shrink, it must be considered in arriving at the master pattern dimensions for that particular section.

2. *Parting line location in critical tolerance sections:* Since it is virtually impossible to remove these parting lines by manual means without also removing surrounding material and reducing the dimensions, here again compensation must be made to allow for this stock removal.

3. *Overhanging sections, such as blade shrouds and buttresses:* Sections such as these will tend to restrict shrinkage both in the wax pattern and the casting. A fast-setting wax and particularly strong investment will minimize the shrink far more than a wax that will continue to shrink for some time after removal from the die, combined with an investment with a low crush strength.

Unfortunately, a dimensionally correct master pattern or die does not necessarily insure acceptable castings. Deviations from normal processing at the casting operation can cause astonishing variations in dimensional measurements. For example, premature gelation of the binding agent causes a mold of very low density, with the result that castings can actually grow 0.010 to 0.012-inch in chordal and thickness dimensions, because of excessive expansion of the investment.

Tolerances: At Misco, experience has shown that the following dimension-to-tolerance ratios are desirable:

- ± 0.003 for dimensions 0.00 to 0.25-inch.
- ± 0.004 for dimensions 0.25 to 0.50-inch.
- ± 0.005 for dimensions 0.50 to 1.00-inch.
- ± 0.005 for each linear inch over 1.00-inch.

It is obvious that the ± 0.005-inch per inch tolerance cannot be made a hard and fast rule because in larger castings the accummulation might cause a tolerance span that would be completely unacceptable. In this case, the casting company must arrive at a tolerance range that is not only satisfactory but represents a practical span for the foundry as well. This tolerance range may vary from company to company, depending on the dimensional stability of the entire process.

From a paper entitled "Dimensional Control and Related Factors" presented at the second annual meeting of the Investment Casting Institute in Chicago, Ill., November, 1954.

(Advertisement)

Report to Cylinder Users . . .

Here at Miller Fluid Power we have a pattern which we follow. A goal at which we are shooting. The pattern isn't too simple. And the goal isn't an easy one. But we've been making progress. Our position right up in the van of the industry proves that.

Our job is the production of cylinders. Basically, there's nothing anyone can do to alter a cylinder. It was old a hundred years ago. It probably won't change basically in another hundred years. But in the details of the cylinder, change is the major element.

Which is very much like industry itself. Basically industry has not changed since free enterprise was conceived on this continent. But in every detail it changes from year to year.

It's the Thousandths That Count

There was no single big thing wrong with the cylinders being manufactured yesterday. Just a lot of little things. So Miller Fluid Power made the improvement of little things its business.

We experimented with new materials and made safer, more dependable steel heads and caps. We hard-chrome-plated 110,000 PSI yield point steel to improve radically the piston rods. We raised the efficiency of operation to new peaks. Striving for quality in the smallest detail we improved in a dozen parts which are hidden from sight.

For instance, most cylinders leaked in operation. Miller made one that wouldn't leak. To prove it, we went away out on a limb and guaranteed leak-proof operation. And made the guarantee stand up.

We Learn by Listening to You

We saw our customers as thousands of men in thousands of shops wrestling with thousands of production problems. We made those problems ours and produced cylinders to whip those problems. Maybe we didn't revolutionize the cylinder business in the process. But we sure helped. We know that.

We learned to produce what we believed was the best cylinder on earth. We also learned that the best cylinder today wouldn't be good enough tomorrow. So, with the good one in production, we listened some more, experimented, and came up with a better one.

Miller Fluid Power is a young company in an old field. We are young, progressive, and willing to listen. We innovate without being prodded.

Discussion is a Two Way Street

On occasion we like to have others listen to us. Especially when what we have to say will help our customers. That is the idea behind our College of Cylinder Knowledge. We know a lot about cylinders. Though not as much today as we will tomorrow or the day after.

In our College of Cylinder Knowledge we try to show you what good cylinders can do for you. And what you should demand in any cylinder you buy. We meet other men who know what they want in a cylinder. We listen to their wants and try to explain what perfection in detail means.

We believe that when the users of cylinders sit down across the table from the producer who is trying to make the best, better cylinders result.

We'll be carrying that belief into the Production Engineering Show at Navy Pier in Chicago on September 6. Our College of Cylinder Knowledge booth will be open for that kind of discussion. We'll listen and learn.

The only way we can learn is from you. We can help you. But not until you've dropped that problem of yours in our lap. Your problem contains the stuff of which the better cylinder will be made. The cylinder that will have that quality plus which we like to think is the stamp of Miller Fluid Power.

Remember this when you see the sign over Booth 1819-23. We'll be there to listen to your suggestions, demands and questions. Also, because we are in the cylinder business, we'll be there to show you a cylinder you will want to buy.

Frank Flick

President

MILLER FLUID POWER COMPANY

2006 N. Hawthorne Avenue

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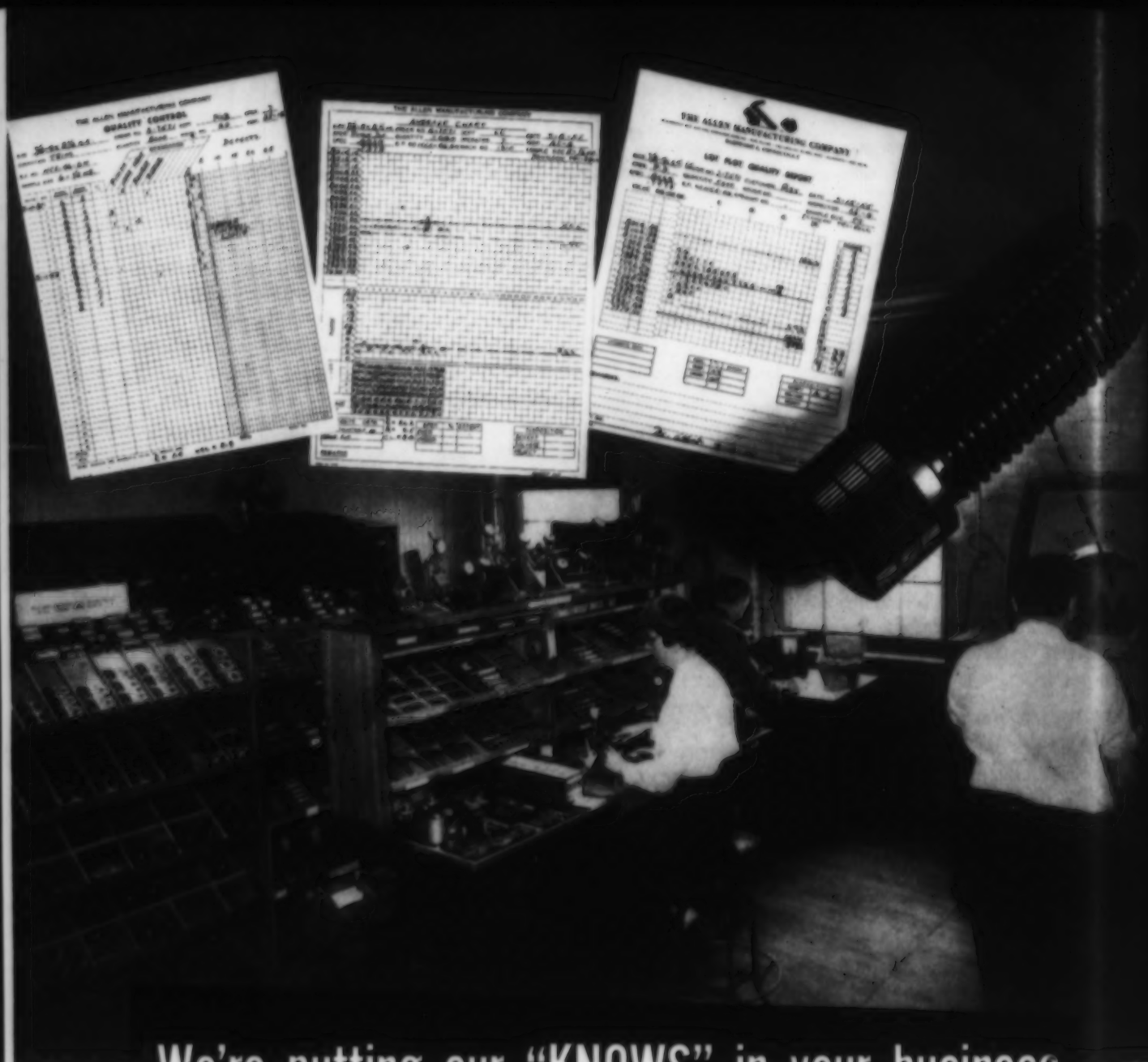

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YOU can take Allen quality for granted ...because we don't!

Long-time Allen customers get into the habit of taking Allen quality for granted. They can do that safely, too – because we never take quality for granted here at Allen.

Quality control here begins with raw materials; they're right, or we don't use them. Tools and gauges are tested and certified before they're used. Allen chart control monitors every machine process, corrects immediately any variation from standards, insures the uniform precision you can rightly expect from Allen. Plating and heat-treating processes are just as rigidly controlled. And at the time of packing, we check again for quality.

Allen quality – No. 1 quality in Socket Screws – is built-in! You can depend on Allen Socket Screws, wherever you use them, to outperform and outlast all others.

Allen engineers are always ready to help you with applications of Allen Socket Screws to your products. They have a wealth of experience in socket screw fastening – ask them to put their "knows" in your business.

When ordering through your local Industrial Distributor, specify genuine Allen Socket Screws

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HELPFUL LITERATURE

FOR DESIGN EXECUTIVES

Liquid Level Controls

Minneapolis-Honeywell Regulator Co., Industrial Div.—Discussion of basic principles of liquid level measurement, control and transmission is contained in 20-page illustrated bulletin 1161. Systems are described in detail, along with applications, principles of operation, limitations and advantages of each.

Interval Timers

R. W. Cramer Co.—Exploded views, descriptive and technical data and wiring, dimension and housing information on line of interval timers are contained in 8-page illustrated bulletin PB-210. Readily adjustable units operate through one complete cycle, then stop each time the pointer is set or the start button is pressed.

Balancing Machines

Gisholt Machine Co.—Improved line of type Dynetric balancing machines featured in 8-page bulletin 1165 are available in both horizontal and vertical models and in several standard sizes. Machines provide means for quickly measuring and locating unbalance in parts weighing from a few ounces to several hundred pounds. Accessories and applications are covered.

Germanium Diodes

International Rectifier Corp. — Company's complete germanium point contact diode line is described in 4-page bulletin GD-2. It provides specifications on high temperature, computer, UHF mixer, meter protection and general purpose diodes. An interchangeability and replacement guide is included.

Rod End Bearings

Southwest Products Co. — Dimensions of Heref (female) and Screm (male) types of Heimball self-aligning rod end bearings are tabulated in 4-page catalog 2155. Supplementary data sheet 1100 shows typical applications.

Variable Speed Motors

U. S. Electrical Motors Inc.—"Automation Through Varitrol Control" is subject of 8-page booklet which shows how improved pneumatic control has been designed into Varidrive motors to improve output. Control permits Varidrive speed to be controlled by pressure, temperature, humidity, viscosity, flow rate, liquid level, tension, weight, CO_2 gas content, pH value and electrical signals. Motors with Varitrol control are available from 1 to 60 hp with speeds from 14 to 14,000 rpm.

7. Powder Metallurgy

Chrysler Corp., Amplex Div.—52-page engineering manual E-55 on powder metallurgy devotes sections to bearings, component parts and filters. Design, loads and speeds, installation, press fit, close-in, shaft clearance, wall thickness, tolerances, temperature change, lubrication, machining, hardening, magnetic properties and flow rates are covered in this treatise. It will aid designers in determining where and how metal powder units can best be used.

8. Piston-Type Accumulators

Parker Appliance Co., Industrial Hydraulics Div.—Complete information on piston-type accumulators and the new precharging accessories is offered in 8-page catalog 1536. Eleven sizes from 10 to 1155 cu in. capacity with rated working pressure of 3000 psi make up line. Accumulators can be used to store energy, absorb shock and supplement pump capacity in hydraulic systems.

9. Solenoid Valves

Skinner Chuck Co., Electric Valve Div.—Line of solenoid valves described and specified in 52-page catalog D1 include 2 and 3-way universal, 4-way all-purpose, 2-way miniature cut-off, 2 and 3-way high pressure hydraulic, 2 and 3-way high-flow industrial and special types. In general, valves handle air, inert gases, petroleum and vegetable oils, water, steam, gasoline, freons and many semicorrosive media.

10. Explosive Rivets

E. I. du Pont de Nemours & Co.—Varieties and sizes of explosive rivets, their application in the aircraft industry, installation instruction and riveting tools are covered in 28-page booklet A-8690. This rivet is a fast-acting, one-piece fastener with an explosive-charged cavity running the length of its shank. Heat applied to rivet head fires charge to set rivet.

11. Long-Stroke Diaphragm

Bellofram Corp.—Various classes of Bellofram long-stroke, deep convolution diaphragms are described in 16-page loose-leaf catalog B.F. 150. Included are table of standard sizes, available materials and dimensional and design data.

12. Instrument Mountings

Bushings, Inc.—Instrumount rubber insulated mountings for instruments, laboratory and other lightweight precision equipment are described in data bulletin 5255. Number of suggested uses are given together with prices, dimensions and load bearing capacities.

13. Lock Nuts & Fasteners

Palnut Co.—Application of Palnut lock nuts and fasteners in radio, television and electronic assembly is depicted in 16-page brochure 580. Regular, washer, tension and inverted type lock nuts are shown, as well as wing nuts, shield can fasteners, coil tube fasteners and tools for Palnut assembly work.

14. Symbolic Logic Systems

Computer Control Co.—Basic symbolic logic used in logical systems, digital computers and pulse data handling is explained graphically in 16-page brochure article "Symbolic Logic, Binary Calculation and 3C-PACs" by R. W. Brooks. Author goes into binary arithmetic, explaining serial and parallel methods of addition as well as binary subtraction.

15. Miniature Ball Bearings

Miniature Precision Bearings, Inc.—Technical data on design and application of precision instrument ball bearings is given in the semimonthly "MPB Engineering News." Volume 1, No. 3 issue discusses "Contact Angle—Its Relation to Radial and Axial Clearances." Author is R. H. Carter, company's chief engineer.

USE THE POSTAGE FREE CARDS BELOW for copies of anything listed on this or following helpful literature pages—or for further information on any items in the new parts section or the engineering department equipment section which you'll find on the next several pages.

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16. Fiber & Plastic Materials

National Vulcanized Fibre Co.—16-page bulletin "Engineering Materials for Modern Industry" covers properties, grades and uses of vulcanized fiber and Phenolite laminated plastic. Case studies match physical properties to such typical uses as transformer coils, circuit breakers, rail joint insulation, gear blanks, abrasive disk backing, chrome plating barrels and printed circuits.

17. Synchros & Servo Motors

Norden-Ketay Corp.—Typical characteristics and specifications for over 130 synchros, servo motors, resolvers, tachometer generators, amplifiers and airborne instruments are provided in 4-page bulletin 355.

18. Investment Casting Alloys

Precision Metalsmiths Inc.—11 x 17-in. chart lists standard investment casting alloys, giving their chemical analyses, mechanical properties and other data. Alloys covered include austenitic and martensitic stainless, low alloy steels, tool steels, nickel alloys, copper base alloys and aluminum alloys.

19. Panel Meters

DeJur-Amsco Corp., Electronic Sales Div.—General specs, range and approximate resistances of series 100 1-in. round and square watertight panel meters are given in data sheet M100-155. Instruments include direct current microammeters, ammeters, milliammeters and voltmeters.

20. Ductile Iron

International Nickel Co.—30-page bulletin DI-25 describes ductile iron, the cast iron that can be bent. Iron combines process advantages of cast iron, such as castability and machinability, with the strength, toughness, wear resistance and ductility of steel. Well-illustrated piece contains case histories, specification tables for seven main types of ductile iron and charts comparing mechanical properties.

21. Remote Control Switch

Automatic Switch Co.—Two new features on the ASCO remote control switch are shown in technical bulletin 568. These include a contact hood to shield switch contacts, available as a separate item or as integral part of new switch, and a reduced width two-pole remote control switch unit useful to switchboard builders.

22. Steel Data

Allegheny Ludlum Steel Corp.—16-page pocket-size folder lists 55 technical data sheets and booklets covering selection, fabrication and application of stainless and heat-resistant steels, tool and die steels, electrical steels and alloys and carbide material of all necessary types.

23. Silver Brazing

Air Reduction Sales Co.—24-page "Brazing Manual" is concerned with the application of major brazing methods in joining metals using silver alloys and filler metals, fluxes and gas atmospheres. Over 20 tables, drawings and photos are included. Subjects covered include silver brazing procedure, selection of metals, design of joints, prebraze cleaning and assembly of brazed joints.

24. Valve-Equipped Cylinders

Carter Controls, Inc.—Over 1900 different mounting size and control combinations of standard Power Pack air cylinders with built-in valves are described in 6-page illustrated bulletin 125. They are usable where automatic and semiautomatic motions are required. Cylinders are operated by air limit control or solenoid switching. All necessary technical data are given.

25. Ball & Roller Bearings

McGill Mfg. Co.—Over 30 pages of general engineering data for ball and roller bearings are included in the 140-page catalog on line of bearings, including sealed Guiderol bearings. Also detailed are engineering and production methods. Dimensional and load capacity tables for each model are included, along with cut-away views, drawings, photos, interchangeability charts and other technical data.

26. Source For Castings

Campbell, Wyant and Cannon Foundry Co.—24-page brochure entitled "One Source" points up company's ability to supply intricate, general purpose, special property, heat treated steel and centrifugal castings. Facilities of its six foundries are illustrated and described briefly.

27. Manufacturing Facilities

Acme Industrial Co.—Synopsis of company facilities for machining, heat treating, grinding, lapping and honing is found in 4-page bulletin 1c/Ac. An example of precision tolerances is shown in ability to lap all types of materials to a flatness within 0.000002-in.

28. Flexible Metal Hose

Flexonics Corp., Chicago Metal Hose Div.—Specifications and general data on line of Flexon flexible metal hose are found in 12-page illustrated bulletin 147. Covered are Rex-Weld bronze and steel hose; Rex-Tube galvanized steel, brass, stainless steel and bronze hose; industrial Rex-Flex stainless steel hose; and couplings and connectors for all hose types. Construction and application data are included.

29. Die Casting Alloys

Parker White-Metal Co.—Engineering data for die casting alloys provided in 14-page booklet covers specifications, tolerance tables and physical properties. Purpose of guide is to help the alloy user make more effective use of die-cast component parts.

30. Hopper-Fed Set Screws

Set Screw & Mfg. Co.—Rapid application, automatic diameter inspection and rejection of misfits, floor space savings and equal success working with all metals and plastics on any product are advantages of Setko hopper-fed headless set screws. They are described in 4-page illustrated brochure, along with mechanism for application.

31. Hydraulic Pumps

Webster Electric—Positive displacement gear type hydraulic pumps for handling noncorrosive liquids with lubricating qualities are subject of 12-page illustrated bulletin H141. Dimensional and construction data are included, along with typical performance data, for units from 1/5 to 30 gpm.

32. Plastic Closures

Protective Closures Co., CaPlugs Div.—Line of threaded and nonthreaded caps and plugs for safeguarding products in process, storage and transit is described and illustrated in multiple-page file folder. Price lists for over 100 stocked sizes of five standard designs used to protect tubing, fittings, valves, hydraulic components and machined parts are included.

33. Aluminum Forgings

Harvey Aluminum—Advantages of aluminum forgings are discussed in 12-page illustrated booklet. Press forgings, impact extrusions and hand forgings are discussed. Mechanical properties of aluminum forging alloys and typical forging applications are summarized.

34. Shock & Vibration Isolator

Barry Controls Inc. — Technical data on miniature All-Angl shock and vibration isolator developed for use in jets and guided missiles are contained in data sheet. They show isolation against shock and vibration in all directions.

35. Locks & Handles

Raytheon Mfg. Co., Equipment Marketing Div.—Line of knob locks and pull handles for use as panel components are described in illustrated data sheet 5-100. General data, test results, design features and specifications are included for locks, while finishes, mountings and other information are given for handles.

36. Constant Force Spring

Hunter Spring Co.—More than 25 design applications of the Neg'ator constant force spring are described and illustrated in 16-page

(*Continued on Page 218*)

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Helpful Literature

(Continued from Page 216)

technical bulletin 310N. It solves a variety of mechanical-loading and power-drive problems. Suggestions to facilitate the design of Neg'ator springs and motors are in the bulletin and sample units are described.

37. Globe Valves

Cooper Alloy Corp.—Major stainless steel globe valves in Cooper Alloy line are covered in 4-page folder 55A. Schematic drawings of various models and a section on design factors are included. Table of stainless alloys gives their designations and applications.

38. Vibration & Shock Control

Robinson Aviation, Inc.—Booklet 900, "New Concept in Vibration and Shock Control for Airborne Electronic Equipment," is available for engineers, designers and manufacturers of this type of equipment. It describes applications for Met-L-Flex all-metal mountings utilizing resilient fabricated metal cushions.

39. Corrosion Resistant Tubing

Carpenter Steel Co., Alloy Tube Div.—Properties, workability, application data and range of sizes are presented in 4-page technical bulletin T.D. 117 on super corrosion resistant tubing and pipe made from B and C alloys. Nickel-molybdenum alloy B resists hydrochloric acid and nickel-molybdenum-chromium alloy C is resistant to strong oxidizing conditions.

40. Fingerprint Remover

E. F. Houghton & Co.—Rejection of metal parts caused by corrosion started from fingerprints can be reduced by use of Cosmoline 1070 fingerprint remover, subject of 4-page illustrated bulletin. It protects critical surfaces from corrosion caused by lactic acid, urea and sodium chloride residue of fingerprints.

41. Low Heat Welding Alloys

Eutectic Welding Alloys Corp.—Applications for low heat input metal joining on all base metals are described in 4-page illustrated folder TIB 2496. Procedures for many common jobs are discussed and techniques and alloys recommendations are given for cast iron repair work without preheat. Various other EutecRods and EutecTrodes are described.

42. Reproduction Materials

Eastman Kodak Co., Graphic Reproduction Div.—Kodagraph materials for preparation and reproduction of drawings and documents are described in detail in 20-page illustrated booklet "Kodagraph Reproduction Materials." Included is a materials selection chart.

43. Feed-Throughs & Stand-Offs

Hermetic Seal Products Co.—Vac-Tite compression, single terminal feed-throughs and stand-offs, subject of 4-page illustrated brochure 400, feature glass-to-metal chemically bonded compression construction. Technical data and drawings for entire line are included. Applications include transformers, relays, condensers and filter networks.

44. Adjustable Speed Drives

General Electric Co.—General purpose full-wave Thy-mo-trol adjustable speed drive is detailed in 8-page publication GEA-6234. Panel and motor construction features are pointed out. Drives incorporate printed circuits and are suited to variety of applications, some of which are shown.

45. Electric Circuit Control

Electric Regulator Corp.—Design details and instructions for use of the Size 4 Regohm direct-action, finger-type electric circuit control regulator are contained in 8-page illustrated bulletin 6.04. Developed for the higher direct-control power ranges, it has wide frequency range and stepless continuous control.

46. Stainless Steel Wire

Crucible Steel Co. of America—32-page illustrated manual "Resistal Stainless Steel Wire" discusses the austenitic, ferritic and martensitic group classifications; the common uses of these wires and typical end products that are manufactured from them. Complete data are presented, including both physical and mechanical properties. Tables list size range and straightened cut lengths for shape wire including squares, hexagons, octagons, flats and special shapes.

47. Machine Tool Lubrication

Trabon Engineering Corp.—"Trabon Lubrication for Machine Tools" is a four page guide to components and systems for automatically lubricating machine tools with predetermined quantities of oil or grease.

48. Asbestos Textiles

Johns-Manville—A page or more is devoted to asbestos lap, roving, yarn, cloth, tubing, cord, wick, rope and tape in 16-page illustrated manual "Asbestos Textiles." Photographs, drawings and data in tabular form are included. Six grades of asbestos have service temperatures up to 900° F.

49. Damping Devices

Gabriel Corp. — "Damping Devices—Past, Present, Future" is a 24-page illustrated treatise on direct-acting damping devices or shock absorbers for industry. Presented is a description of the development and use of closed-circuit diagrams and load-velocity charts for the measurement of damping device performance. Six standard industrial damping devices are shown and specifications given.

50. Hardness-Lubricity Tester

Taber Instrument Corp.—The Dyhedron dynamic diamond tester is designed to measure the hardness and lubricity of such materials as metals, plastics and ceramics. Full details on the application and operations of this equipment are given in 6-page illustrated folder 5501.

51. How To Finish Aluminum

Aluminum Co. of America—48-page illustrated design manual "Finishes for Alcoa Aluminum" deals with the amazing variety of finishes that are possible with aluminum and its alloys. Full-color illustrations serve to show both the texture and color ranges that are obtainable. Finishing methods, characteristics of various finishes and other factors are covered.

52. Automatic Controls

Assembly Products Inc.—Simplytrol automatic pyrometers for temperature control in industry and pyrometer limit controls for safety shut-off or warning are subjects of 4-page illustrated bulletin G-8. Controls are offered for temperature ranges of —200°/100° F to 0°/3000° F.

53. Air-Powered Devices

Mead Specialties Co.—"Air Power Automation" is an idea-packed 28-page guide to the use of air cylinders, controls and other air-operated devices in converting machines and equipment to automatic or semiautomatic operation. Examples are cited in case history form, and hookups show typical timing, feeding and work cycle applications.

54. Airborne Electrical Power

Westinghouse Electric Corp.—Systems engineering; development, environmental, mechanical and load tests; and manufacturing facilities are some of the subjects covered by 32-page illustrated bulletin B-6392 on airborne electrical power. Booklet emphasizes the extensive facilities available and necessary for developing, producing and testing aircraft electrical systems and components.

55. Recycling Circuit Controller

Counter & Control Corp.—Illustrated 8-page bulletin 505 gives performance data on the Programonitor, a multistage circuit controlling counter with automatic recycling. With this device it is possible to program almost any variety of switch functions with respect to a continuously repeated count-cycle.

56. Glass-Enclosed Switch

Revere Corp. of America—Glaswitch, a sensitive magnetically operated control element for general industrial applications is described in 20-page engineering bulletin 1607. Operation, performance and characteristics of the 2½-in. long glass-enclosed switch are given. It operates in any position in 1 millisecond or less at rates as high as 400 cps.

57. Grinder Coolant Filters

Industrial Filtration Co.—"Delpark Coolant Filters for Use on Besly Grinding Machines" is a 4-page bulletin which gives design and performance data on these full-flow, self-cleaning, continuous and fully automatic units.

58. Industrial Fluid Drive

American Blower Corp.—8-page illustrated catalog and selection guide 9419-9519 is descriptive of the new type VS class 2 Gyrol fluid drive for general purpose industrial applications. Tables aid in selecting proper drive to use with motors rated from 7.5 to 800 hp. Six drive sizes are available with both crank and lever type speed control mechanisms.

59. Magnetic Brakes & Clutches

Stearns Magnetic, Inc.—Transmission bulletin No. 226-D deals with design and application of a line of magnetic clutches and brakes. Complete selection data are given together with specifications of a companion new line of magnetic brakes for the NEMA rerated motor frame sizes.

60. JIC Pneumatic Standards

Miller Fluid Power Co.—Unabridged edition of the latest "JIC Pneumatic Standards for Industrial Equipment" incorporates all revisions made at the January 1955 meeting of the Joint Industry Conference. This 12-page guide includes two pages of graphic symbols, a sample pneumatic circuit using these symbols, a glossary of terms and design details of Miller 200-psi air cylinder.

61. Drives Data

W. A. Jones Foundry & Machine Co.—"Better Drives" is the title of a bi-monthly publication which will be devoted to presenting data on the application of power transmission equipment to industrial machines and needs. All types of drives will be covered. Designers interested will be placed on the mailing list to receive this publication regularly.

62. Water Filters

Marvel Engineering Co.—12-page illustrated catalog 300 is devoted to design, performance and application information on line of Synclinal filters for water. These large-capacity filters can be furnished with 30 to 100-mesh Monel wire cloth elements as standard and up to 200-mesh on special order. Capacities range up to 100 gpm. Included is theoretical flow and pressure drop table for ¼ to 2-in. pipe.

63. Adhesives, Coatings & Sealers

Minnesota Mining & Mfg. Co.—The use of 3M brand adhesives, coatings and sealers for joint sealing, and bonding and protecting sheet metal in manufacturing and construction is subject of 4-page illustrated folder 3M7. Eight typical applications are described.

64. Coolant Pumps

Graymills Corp.—38-page illustrated catalog is compilation of data and performance sheets describing coolant, circulating and agitating pumps. Charts and tables simplify selection and application.

65. Industrial Casters

Albion Industries, Inc.—6-page illustrated mailing piece presents capsule descriptions of complete line of "Load-Rated" casters as well as special casters which can be furnished to suit any need. They can be supplied with plain, ball or roller bearings and with Rollte and Noflex, molded Textite, semisteel, molded, pneumatic or semipneumatic wheels in wide range of load ratings.

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STANDARD GEAR SETS (RIGHT HAND) TOOL CHARTS & HORSEPOWER
STANDARD
HUB TYPE BRONZE GEAR BLANKS
GEARING TYPES AND SPIDER STANDARDS

Specify STANDARD Cone-Drive Gears and get all these advantages

plus this vital feature

Standard *Cone-Drive gears and worms are carried in stock. Cone-Drive gears are noted for their long life—BUT if a failure should occur at any time, replacement gears and worms are available without delay.*

Ask for Catalog No. 700

Lower Cost—due to smaller size of gears and housings, mass production of worm and gear blanks, etc.

Compactness—due to distribution of load over greater contact area, reducing unit pressures. As a result, gear sets can have smaller center distances, enclosures can be smaller, etc.

Less Weight—due to smaller center distances for a given horsepower or torque. Other types of gearing weigh up to 3 times as much for the same horsepower transmitted.

Greater Smoothness—because Cone-Drive gears have more teeth in continuous contact than other forms of gearing.

Wide Range of Sizes—Center distances from 2" to 18" provide horsepower ratings from fractional up to 800 horsepower. Ratios range from 5/1 to 70/1.

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DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS

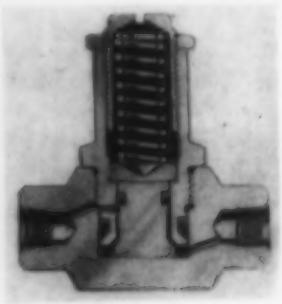
Division Michigan Tool Company
7171 E. McNichols Road • Detroit 12, Michigan

NEW PARTS AND MATERIALS

For additional information on these new developments, see Page 215

Adjustable Gage Protector

Cartridge type gage protector is designed for use in hydraulic systems with working pressures up to 10,000 psi. It has a spool-like plunger within a removable cartridge. Connections are in-line, and spring pressure adjustments, or changes of cartridge are made without removing the device from the line. Springs are available for standard maximum gage readings from 15 to 5000 psi. When line pressure reaches spring setting, the plunger shuts off the gage instantly. It opens immediately

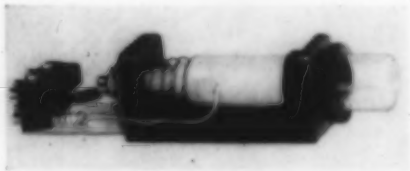


when pressure returns to normal. Standard body materials are aluminum and stainless steel. Line port opening is ¼-in. FPT. Made by **Republic Mfg. Co.**, 15655 Brookpark Rd., Cleveland 11, O.

For more data circle MD-66, Page 215

Illuminated Switch

An indicating light is an integral part of the pushbutton in the 31PB1 switch for electronic, aircraft, mobile, marine, railway and other alternating or direct current applications using low voltages. A socket is provided inside the head

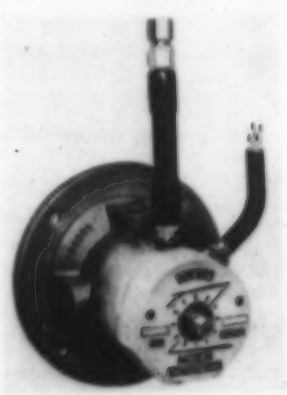


of the pushbutton for a single-contact miniature bayonet lamp. A terminal block is provided, and power to turn on the indicator light when the switch is operated must be picked up from the circuit being switched by means of direct connection, or by using a relay. Single-pole, double-throw switching unit is rated 125 or 250 v ac, 5 amp; 30 v dc inductive, 3 amp at sea level. Maximum inrush is 15 amp. Made by **Minneapolis-Honeywell Regulator Co.**, Micro Switch Div., Freeport, Ill.

For more data circle MD-67, Page 215

Air Seal-Cycle Timer

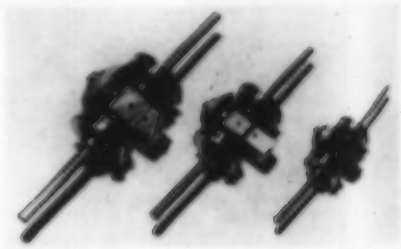
Functions of air seal and cycle timer are combined in the Timing Rotorseal, a compact, self-contained, sealed unit for installation on presses and other machine tools. Designed for operation up to 500 rpm, it accomplishes timing of the



operating cycle by multiple limit switches which control air pressure to clutch and brake. Adjustment of flat of the cams is 360 degrees, clockwise or counterclockwise. Timing Rotorseal is offered as a complete unit or as an integral part of a packaged unit for converting OBI and straight-side presses from mechanical to pneumatic clutch and brake. Flywheel hub-mounted and shaft-mounted types are available. Made by **Fawick Corp.**, Fawick Airflex Div., 9919 Clinton Rd., Cleveland 11, O.

For more data circle MD-68, Page 215

Differentials and Change Gears



Made in ⅛, 3/16 and ¼-in. shaft sizes, type *V* precision mechanical differentials are designed for use where high precision calculating mechanisms are required. They combine two rotating inputs into one rotating output that is the algebraic average of the inputs. The differential end spur gears are machined to precision AGMA 1 tolerances. They are clamped by a retaining ring to permit assembly and disassembly. Adjustable counterbalance on center spider provides smooth and uniform operation. Differentials are stainless steel throughout, with the exception of the aluminum spider

A SIMPLE CONCEPT IN LUBRICATION...

that protects any machine ... any bearing surface!

ALEMITE OIL-MIST

This Oil-Mist lubricator atomizes oil into minute particles which are carried in the air stream through tubing to bearings. Compressed air enters through the air regulator (1) and air gauge (2). As the air passes the venturi (3) it draws oil from the reservoir (4). Oil flow is set by knob (5). The oil-air mixture is thrust against baffle (6), and only the tiniest, lighter-than-air particles are blown through the outlet (7) and through the delivery line to bearings.

Proved in countless applications—multiplies bearing life—slashes product spoilage—boosts machine output!

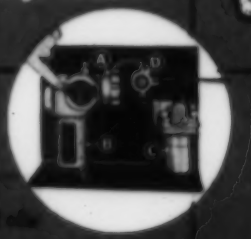
It's a simple idea in lubrication, and like most simple ideas, it's very sound. Easy to incorporate into new designs, equally easy to apply to machines already installed. Oil-Mist applies a constant, clean, cool film of oil uniformly to working parts—bearings, slides, vees, chains, gears—wherever needed. And in the form needed: Liquid, spray or mist. Replaces grease systems. No moving parts—operates on compressed air—completely automatic, fool-proof!

Three types of bearing fittings allow the use of OIL-MIST on any machine!

Oil-Mist fittings bring the most efficient lubrication in the world to any anti-friction bearing—roller, ball, handle.

Spray fittings are recommended for open and enclosed gears and chains. Allow for a concentrated spray of oil where needed.

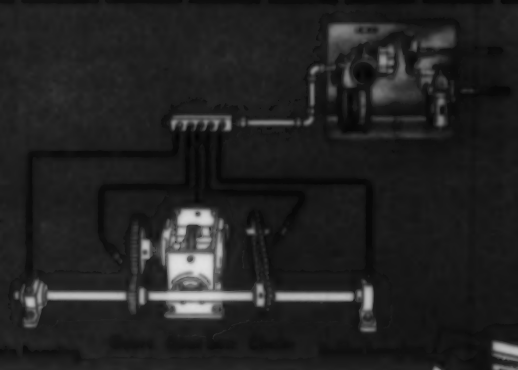
Condensing fittings apply oil in liquid form to plain bearings, slides, ways, vees, cams and rotors.



Lubricator Specifications

- Air regulator (A) reduces from pressure up to 200 psi. Normal air consumption, .7 to 1.2 cfm.
- Operating pressure, 5 to 20 psi. • Range of oils handled: to 1,000 sec. (S.U.V.) @ 100°F.
- Oil reservoir (B) capacity 12 oz. (One week's average supply) • Baffle-type water separator (C) is automatic—self-dumping.
- Solenoid Control (D) starts system as machine starts.

Complete range of models and multiple unit models—Capacities 12 oz. to one gallon to fit any application!



Alemite Oil-Mist offers these lubrication advantages

Automatic lubrication • Continuous lubrication
Eliminates guesswork • Greater safety • Cuts oil consumption up to 90%
Extends bearing life • Stops oil drippage • Saves man-power
Reduces number of lubricants needed • Eliminates "Down-time"

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bevel gear. Change gears are available in 48, 64 and 72 pitches, 20-deg pressure angle, with from 63 to 160 teeth. The end spur gears are available in both stainless steel and aluminum. Made by **PIC Design Corp.**, 160 Atlantic Ave., Lynbrook, L. I., N. Y.

For more data circle MD-69, Page 215

Straight-Thread Fitting

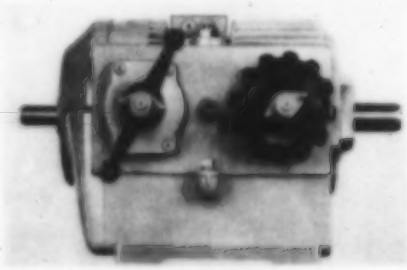
Hydraulic fitting with straight threads locks in place and seals the port against fluid leakage. Port and fitting are protected from overstress and damage. This CN fitting can be used with the L and L and AND-10050 type straight thread ports. The former can be sealed with or without an O-ring; the latter port requires an O-ring for sealing. Fittings can be assembled and reassembled repeatedly without damage to port or fitting. Elbows and tees can be positioned without over-torque of threads. Fittings will be

available as straight connectors, 45 and 90-deg elbows, tees and all other shapes to fit ⅛ to 2-in. OD tubing. Made by **L and L Mfg. Co.**, 8088 E. Nine Mile Rd., Van Dyke, Mich.

For more data circle MD-70, Page 215

Adjustable-Speed Transmission

This compact, self-contained adjustable-speed hydraulic transmission consists of a driven oil pump and an output oil motor. These rotating elements are incorporated in one air-cooled housing which also acts as the 6-qt oil reservoir. All working parts are self-lubricated from the reservoir. Low internal operating pressures of 300 to 350 psi and ball-bearing construction contribute to long operating life. The transmission can be directly coupled to the electric motor supplying the constant speed

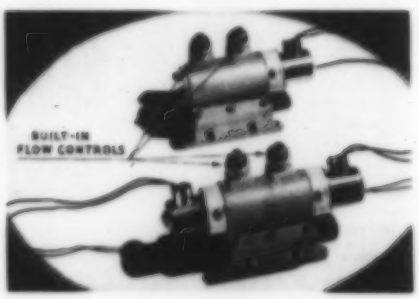


input power, or can be belt-driven from a side or top-mounted motor, depending upon space limitations. The output speed at constant torque can be regulated by stroking the pump; likewise, constant horsepower is achieved through stroking the motor. Changes of speed and direction of rotation can be made during operation or while the unit is not operating. Input speed is 1200 rpm; output speed is variable up to 1500 rpm. Maximum torque is 525 lb-in. at output speeds of 60 to 425 rpm. Made by **Gerotor May Corp.**, P. O. Box 86, Baltimore 3, Md.

For more data circle MD-71, Page 215

Pilot-Operated Valves

Base-mounted air-control valves, designed to meet JIC standards, are for use where continuous operation and compact piping are required. Double and single-solenoid, pilot-operated control valves are available. Both have built-in flow controls which make them dual-



purpose valves. Two internal moving parts are a single balance spool type stem that rides on an aircraft type packing and the solenoid pilot plunger with molded-in seats. The completely sealed double-solenoid valve has two solenoid pilot plungers. It can be energized through a miniature switch or a relay. The single-solenoid valve has a spring return for electrical control. Electrical contact must be maintained for the duration of the cycle. The solenoids are rated as continuous duty with a power consumption of 10 w maximum. Valves can be supplied for most ac and dc voltages and are available in sizes of ¼, ⅜, ½ and ¾-in., with pipe-tap size ports. Operating pressures range from 20 to 150 psi air pressure for the double solenoid and from 35 to 150 psi for the single solenoid. Made by **Airmatic Valve Inc.**, 7317 Associate Ave., Cleveland 9, O.

For more data circle MD-72, Page 215

Transistor Transformer

This miniature interstage transistor transformer measures ⅜ x ⅜ x ⅜x-in. Impedance of the interstage primary is 20,000 ohms, and the secondary is 1000 ohms. Frequency response is ±3 db from

150 to 15,000 cycles per second with 0.25-ma dc in the primary. The transformer will handle up to 0.5-milliwatts. Output and input models are available on request. Made by **Telex Inc.**, E-A Div., Dept. KP, Telex Park, St. Paul 1, Minn.

For more data circle MD-73, Page 215

Motor-Generator

Size 11 motor-generator is comprised of a standard G-M size 11 precision servo motor and a drag cup generator assembled in a single stainless steel housing. The motor is designed for operation on 115-v, 400-cycle current. It has 0.6-oz-in. stall torque and no-load speed of 5200 rpm. The generator is wound for 115-v, 400-cycle ex-

The *All-Metal* Multi-directional Mounting*

ROBINSON originated and universally APPLIED

*This multi-directional mounting, when installed as recommended, protects equipment from imposed vibration and shock emanating from any angle and permits installation and use in any position.

ROBINSON Series 9300 plate type double acting multi-directional mount shown here in actual size No. 1, and available in any size required. Load ranges per mount:

Model 9301 ..... 1/2-3 lbs. Model 9303 ..... 2-7 lbs.
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Natural frequencies 12-15 c.p.s.
Higher stiffnesses available.
Special designs upon request.

1955
1954
1953
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ORIGINATED BY ROBINSON in 1949, the all-metal multi-directional mounting was designed to meet the radically new and different problems of ***guided missiles and jet aircraft*** requiring protection of electronic equipment from every angle against shock and vibration.

ENGINEERED AND TESTED in 1950, in the laboratory under rigorous specifications anticipating actual use, and in field tests far exceeding probable requirements, this mounting was quantity produced only when its performance had been demonstrated.

SERVICE PROVED AND UNIVERSALLY APPLIED since 1951, Robinson multi-directional mountings are now preferred for practically all military and commercial aircraft and in the newest of the guided missiles.

RADICALLY DIFFERENT from all other shock and vibration control mountings, this Robinson mount furnishes unique performance because of the inherently damped resilient cushions of patented Met-L-Flex, exclusively Robinson. No auxiliary damping means is required or used. Met-L-Flex is unaffected by attitude, extremes of temperature, aging, or the presence of oil, dust or dirt.

WHEREVER UNFAILING PERFORMANCE of equipment under maximum environmental difficulties is required, ***only Robinson*** multi-directional mountings will meet the difficulties involved.

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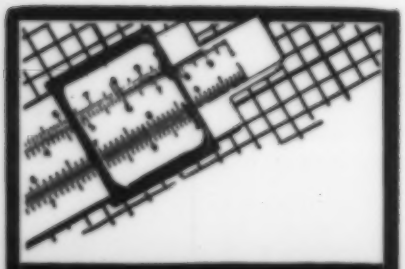
WEST COAST ENGINEERING OFFICE—Complete engineering design and test service. 3006 Wilshire Blvd., Santa Monica, California.



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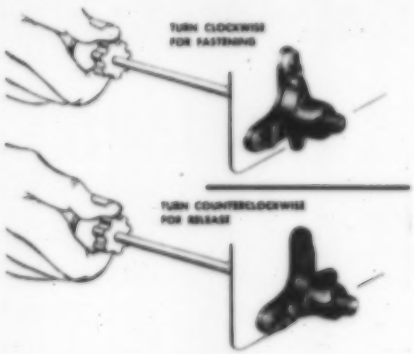
citation with a residual voltage of 0.019-v rms and output voltage of 0.5-v per 1000 rpm. Unit can be wound for other voltages. Dimensions are 1 1/16 in. in diameter and 2 17/32 in. long. It operates over a wide temperature range, under conditions of high humidity and at high altitudes. Made by **G-M Laboratories Inc.**, 4300 N. Knox Ave., Chicago 41, Ill.

For more data circle MD-74, Page 215

Rotary Latch

Operating with a quarter-turn, the Paneloc rotary latch minimizes removal time for such hinged or removable parts as inspection

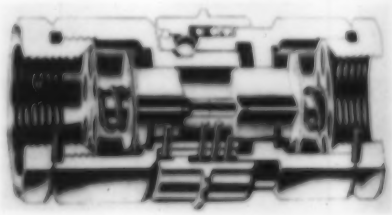


doors, access panels, covers, electrical control panels and machinery doors. Latch is composed of four cadmium-plated steel parts and is assembled on the access panel only. Three standard sizes are currently available. Special sizes can be ordered. Made by **Scovill Mfg. Co.**, 99 Mill St., Waterbury 20, Conn.

For more data circle MD-75, Page 215

Couplings

Quick-connect, quick-disconnect model E couplings can be used for high pressure as well as for gravity flow and vacuum. They provide instant line shut-off when equipped with valves. The small sizes of this model coupling hold vacuums in the micron range in both connected and disconnected positions. The packing provides a positive seal when the coupling is connected, and strong barrel springs hold the valves closed when it is disconnected. Full flow with minimum pressure loss is assured because of coupling's large inside diameter and recessed valve washers. These washers provide a positive metal-to-metal stop when the valve is closed, controlling compression and displacement of the valve washers. Couplings are available with or without valves. Standard finish is heavy cadmium

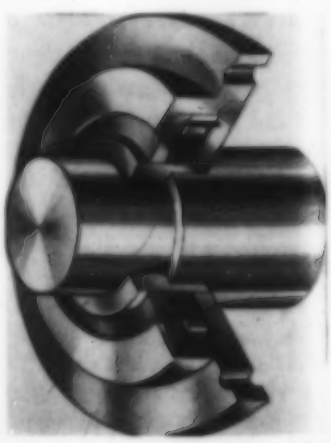


plating, but various other finishes are available. Sizes range from 1/8 to 3-in. ID; couplings up to 10 in. ID can be ordered. Made by **Snap-Tite Inc.**, 201 Titusville Rd., Union City, Pa.

For more data circle MD-76, Page 215

Turbine Shaft Seal

Thermal expansion improves the efficiency of this floating seal for use in high-speed air and gas turbines. Designed to function at temperatures as high as 1400 F and shaft speeds up to 150,000 rpm, it will seal interior pressures even where some eccentric shaft rota-



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Sandusky Foundry technicians and engineers are constantly developing means of producing better ferrous and non-ferrous centrifugal castings. Experienced production personnel, the latest in product control, extensive field testing and laboratory research assure close grained, sound castings of maximum strength, added to extreme resistance to heat, corrosion, and abrasion.

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FERROUS AND NON-FERROUS

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New Parts

tion is present. Seal rotor moves axially and is free to float, either by pressure of gas or by a light spring load. A single or double stator is used. Mating faces are lapped to flatness less than the molecular size of gas or fluid. Close axial tolerance between rotor and stator prevents leakage. Rotor can be carbon, ceramic or metal, depending upon operating conditions. Made by **Cartriseal Corp.**, 3515 W. Touhy Ave., Lincolnwood 45, Ill.

For more data circle MD-77, Page 215

Variable Speed Reducer

Zero-Max infinitely variable speed reducer model 143 has constant torque rating of 30 lb-in. Speed range is from zero to one-fourth input speed. Unit will deliver 0 to 450 rpm with an 1800-rpm input speed. At 400 rpm it is rated at 1/3-hp. Speed changes are

made with control lever. Speed can be changed whether unit is running or not. Reducer can operate indefinitely at any speed without harm, and at zero speed, will operate without heating. Made by **Reveo Inc.**, 2 E. Franklin Ave., Minneapolis 4, Minn.

For more data circle MD-78, Page 215

Multiple-Station Switch

Pushbutton Multi - Switch is available with 2 to 12 station and a choice of mounting centers. Center-to-center distance between buttons is 5/8-in. Plungers accept standard push-on buttons. Stack switches are mounted on a separate plate, permitting operation of up to four stacks by each button. Switching action between stations is controlled so that contacts of a released station will return to nor-

For You..."Right-Now" Help From an Emerson-Electric Motor-Drive Specialist

What kind of motor-drive help do you need—now or later? If it has anything whatever to do with appliance motors, here's your man—with a background of 65 years of specialized experience in power drives, he can give you valuable on-the-spot help.

An Emerson-Electric motor-drive specialist will start at the beginning, or idea stage, of your problems—will stay with it through every phase of development, test and application stages—will work closely with your engineering and management personnel on any product or sales improvement you have in mind.

Call an Emerson-Electric motor-drive specialist . . . even if you have no immediate problem, he'll be glad to confer with you. He may be able to make a suggestion you'll find valuable. No obligation, of course.

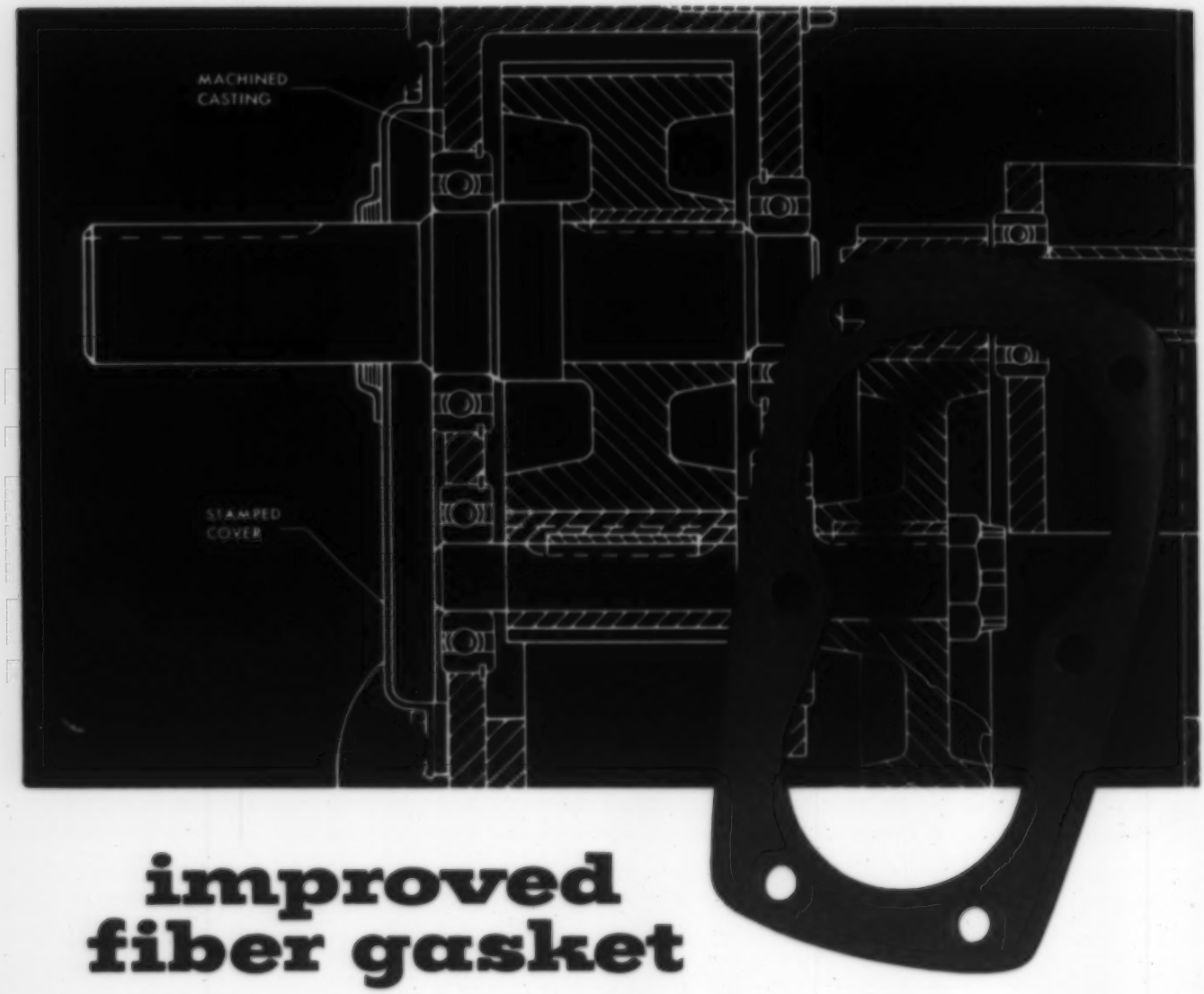
Emerson-Electric supplies motors for appliances and equipment principally in these classifications. Oil Burner • Blowers • Unit Heaters • Water Circulators • Air Conditioning • Washers • Driers • Ironers • Garbage Disposers • Refrigerators • Freezers • Water Pumps • Air Compressors

Emerson-Electric
of St. Louis • Since 1890

Write THE EMERSON ELECTRIC MFG. CO., ST. LOUIS 21, MO., for bulletins listed below.

- ☐ M 4018-A Capacitor-Start
- ☐ M 4018-B Split-Phase
- ☐ M 4018-C Integral
- ☐ M 4018-D Fan Duty
- ☐ M 4018-E Oil Burner
- ☐ M 4018-F Jet Pump
- ☐ M 4018-G Blower

BRANCHES: New York 7, N. Y., 11 Park Place • Chicago 23, Ill., 1623 S. Pulaski Road • Syracuse, N. Y., 209 Oakley Drive • Detroit 7, Mich., 1375 E. Jefferson Ave. • Los Angeles 42, Calif., 5415 York Blvd. • Davenport, Iowa, 617 Brady St. • Cincinnati 11, Ohio, 2917 Ratterman Ave.



improved fiber gasket

stops bolt torque loss, ends cover plate leakage

Customers were complaining that frequent tightening of bolts was necessary to prevent oil leaks at the cover plate of a motor speed reducer. The manufacturer learned that the molded seal between the cover plate and gear housing flowed under pressure and permitted oil to leak. The situation was especially serious since many of the speed reducers were used in food processing equipment where even slight oil leaks could not be tolerated.

By changing from a cast metal to a stamped face plate and using a fiber gasket, the manufacturer hoped to reduce torque loss. But when he tested several conventional fiber materials in the new joint, each one in time lost its saturant, shrank, and leaked.

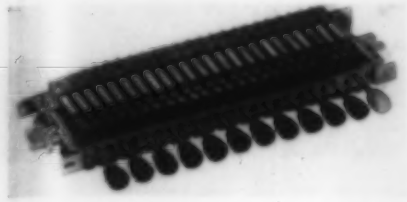
An efficient seal was found, however, when Armstrong CS-301 Accopac® fiber sheet was used. This low-cost gasket material retained its non-extractable latex binder . . . it did not shrink or leak. And its excellent kickback maintained bolt torque.

The dependability of Armstrong Accopac helped this manufacturer find an economical solution to a serious problem. Possibly it can do the same for you.

FREE 24-PAGE MANUAL—For data on Accopac and facts on Armstrong synthetic rubber, cork composition, and cork-and-rubber, look for "Armstrong Gasket Materials" in Sweet's product design file. For your own copy, write Armstrong Cork Company, Industrial Div., 7008 Dean St., Lancaster, Pa. **When you order from your local gasket fabricator, be sure to specify Armstrong Gasket Materials.**

Armstrong Accopac

. . . used wherever performance counts



mal before contacts of a newly operated station are actuated. A number of switching functions and combinations of functions are possible. Design permits changing the function easily. Switches can be provided with fine silver contacts or with welded cross-bar palladium contacts. They are shock resistant. Depth required behind panel is 3 17/64 in.; width is dependent on the number of stations; height is variable depending on the circuit. Made by **Switchcraft Inc.**, 1328 N. Halsted St., Chicago 22, Ill.

For more data circle MD-70, Page 215

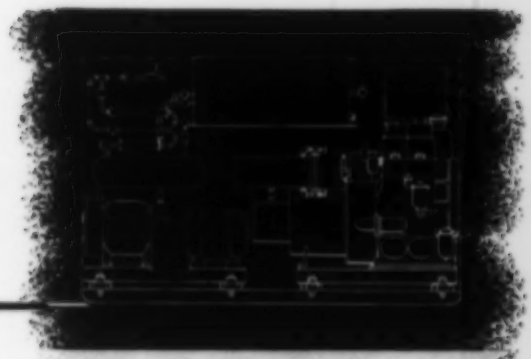
Fractional-Horsepower Motor

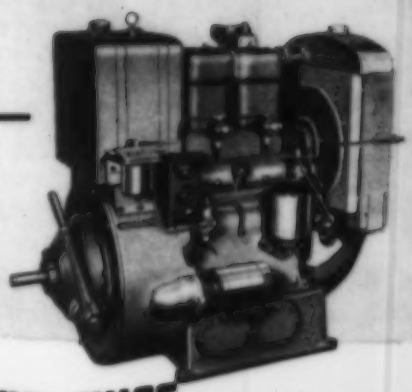
Heavy-duty fractional-horsepower motors, designed for use on machine tools, are factory lubricated with an oxidation and moisture-resistant grease for ten years' service under normal conditions. The motors are totally enclosed and fan-cooled. Welded-on steel base and ball-bearing design help to protect them against shock and vibration and maintain accurate

alignment. Built for frequent starting and stopping, the motors have normal torque for starting, high pull-up torque for inertia loads, and high breakdown torque for peak loads. Insulation provides resistance to heat, aging, moisture and electrical stresses. Rated at ¼, ⅓, ½ and ¾-hp, the polyphase

(*Continued on Page 232*)

for a perfect match of **Machinery** and **Power...**





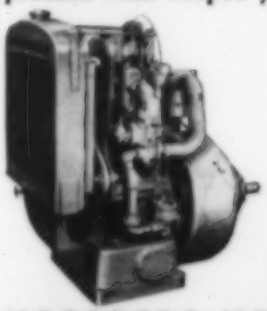
Specify

NORDBERG POWER CHIEF ENGINES!

Why compromise the efficiency of your product to utilize a stock engine when you can get more efficient design with engines built to match your exact requirements?

In the range of 10 to 45 horsepower, or 6 to 30 kilowatts, Nordberg *POWER CHIEF* Diesel Engines can be furnished as both stock engines and as "engineered power packages" with any type of drive, generator, or special equipment you need to assure complete integration of machine and power plant.

Add Nordberg engineering "know-how" to your own to add maximum efficiency and dependable, low cost operation of your product. *Mail coupon for further information.*



NORDBERG *POWER CHIEF* GAS ENGINES

Nordberg *POWER CHIEF* Spark-Fired Gas Engines provide up to 18 hp, stub shaft or clutch power take-off; and up to 10 kw as "packaged" generator sets. Presently available only as single cylinder units, with 4½" bore x 5¼" stroke.

© 1955, Nordberg Mfg. Co.

NORDBERG MFG. CO., Milwaukee, Wisconsin

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Builders of America's Largest Line of Heavy Duty Diesels

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Please send full details on Nordberg *POWER CHIEF*
☐ Diesel Engines ☐ Spark-Fired Gas Engines
(Check one or both)

Name_____
Company_____
Address_____
City_____ Zone____ State_____

4-155-OEM

from tumblers to trailers...get the most

ALUMINUM

Photograph shows 1700-ton hydraulic press in operation at a Reynolds plant. Work in progress is one of the largest drawn aluminum parts ever made—a one-piece 12' x 4' 8" hull for an aluminum boat. This press is currently producing other drawn parts 6' in diameter.

REYNOLDS ALUMINUM

BLANKING · EMBOSSING · STAMPING · DRAWING · RIVETING · FORMING · BRAZING

from your designs with

PRESS PARTS

from REYNOLDS

Square corrugated trailer siding is being fabricated here on a brake press. Brake presses from 22½ to 300 tons are available for your requirements by Reynolds Aluminum Fabricating Service.

Washing machine tubs being fabricated here are one example of countless quality parts that can be produced to your specifications by Reynolds Aluminum Fabricating Service.

Here is part of a battery of medium presses in a Reynolds plant. Large, medium or small—Reynolds Aluminum Fabricating Service has presses to fit your every need.

If your designs call for aluminum parts that require blanking, punching, drawing, forming, stamping, piercing or other press operations, Reynolds Aluminum Fabricating Service can produce these parts to your specifications quickly, efficiently and economically.

The great variety of Reynolds specialized equipment permits you to obtain the economy of the machines best suited to your purpose without making the tremendous capital investment in equipment and added plant capacity which would otherwise be required. Reynolds quality control from mine to finished product and Reynolds experienced design and engineering service go hand in hand with these facilities to assure you the most from your designs.

In two plants alone, out of the more than 30 Reynolds plants in 18 states, Reynolds offers 128 presses including mechanical presses from 2 to 1700 tons and hydraulic presses from 300 to 5000 tons. Reynolds can furnish press parts from simple blanks to deep drawn parts of large area; from very thin to the thickest aluminum that can be drawn.

For full details on these operations and on the many other services offered by Reynolds Aluminum Fabricating Service, call the Reynolds office listed under "Aluminum" in your classified telephone directory or write *Reynolds Aluminum Fabricating Service, 2061 South Ninth Street, Louisville 1, Ky.*

FREE:

Write for your copy of the 24-page "Catalog of Facilities." Get full details on the tremendous production facilities of Reynolds Aluminum Fabricating Service.

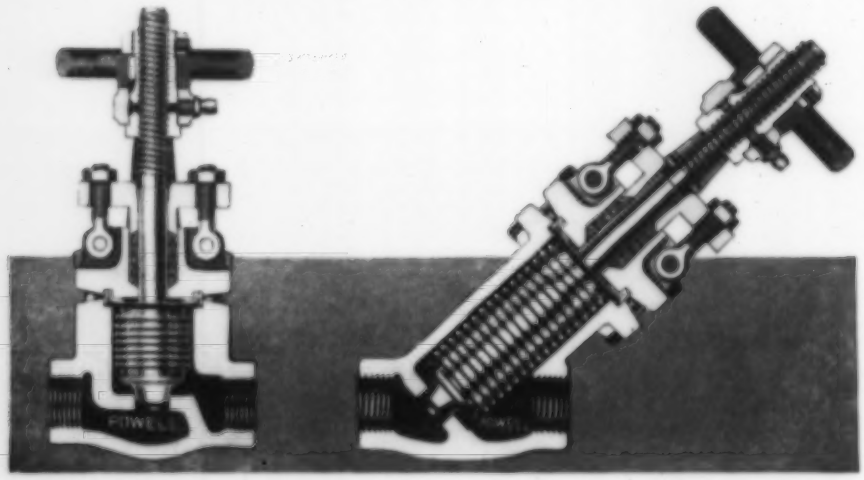
See Reynolds "Do-It-Yourself" program, Sunday nights on NBC-TV

FABRICATING SERVICE

ROLL SHAPING · TUBE BENDING · WELDING · FINISHING · IMPACT EXTRUDING

FLEXON BELLOWS *Design Briefs*

Corrosion Resistant Valve Designs Employ Flexon Bellows To Isolate Bonnet from Flow



Good examples of how to seal a valve stem without packing are the valves illustrated. These are manufactured by the Wm. Powell Co., Cincinnati, for handling a wide range of corrosive fluids.

To isolate working parts from the flow and/or prevent contamination of the fluid being handled, Flexon Bellows are used to seal the stem opening. One end of the bellows is welded to the stem; the other end is welded to a disk that fits snugly in the gasketed female body-yoke joint.

Flexon Bellows used are stainless steel, Monel or brass depending on service. In some services the bellows must withstand pressures up to 1,000 psi, temperatures from —65° to 1500° F.

This is just one of countless seal problems that can be solved effectively with Flexon Bellows. A few of the many other uses for Flexon Bellows are given at the left. For specific recommendations, send an outline of your problem.

FLEXON OFFERS THE COMPLETE BELLOWS SERVICE

Flexonics Corporation manufactures a complete range of bellows and bellows assemblies in brass, bronze or stainless steel for vacuum equipment, thermostatic devices, pressure controls, packless valves, pneumatic instruments, hydraulic mechanisms, rotating shaft seals and many other services.

The Flexon Bellows Design Guide gives valuable application and design information. Write for your copy, today.

Flexonics *Corporation*

FLEXON BELLOWS DIVISION

1339 S. THIRD AVENUE • MAYWOOD, ILLINOIS

FORMERLY CHICAGO METAL HOSE CORPORATION

Flexon identifies products of Flexonics Corporation that have served industry for over 53 years.

Manufacturers of flexible metal hose and conduit, expansion joints, metallic bellows and assemblies of these components.

In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

New Parts

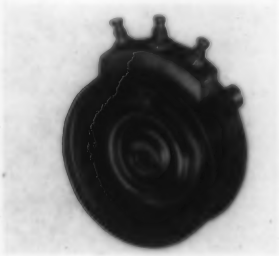
(*Continued from Page 229*)

motors are available with speeds of 1725 or 1425 and 1140 or 950 rpm at 60 or 50 cycles, and in voltages of 208-220/440, 220/380, and 550. Made by **General Electric Co.**, General Purpose Component Motor Dept., Schenectady 5, N. Y.

For more data circle MD-80, Page 215

Subminiature Potentiometers

Series of subminiature precision potentiometers weigh only ½-oz each and are ⅞-in. in diameter. Designated series C-078, they incorporate multiple-finger contact brushes and gold-plated slip rings and terminals. Electrical rotation is 320 deg. Units are completely

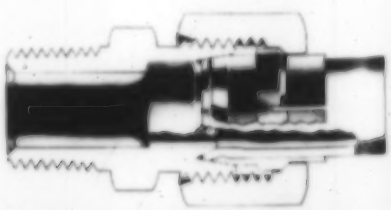


enclosed and can be ganged and independently phased. They are also available with special torque ratings, ball bearings, sealed housings, special tolerances and other requirements for any linear or nonlinear function. Available from **DeJur - Amsco Corp.**, Electronic Sales Div., 45-01 Northern Blvd., Long Island City 1, N. Y.

For more data circle MD-81, Page 215

Self-Flaring Fitting

New Combination fitting has a hard metal wedge insert secured in the connector body. Tubing is supported internally by this insert, upon which self-flare is made as the nut is tightened. No mechanical flaring is necessary. Fitting can be disassembled repeatedly



Where non-metallic or "soft" gasket materials are to be specified, design engineers will find only VICTOR with the complete line of packings for each specific need.

For automotive or aeronautical purposes, you choose from dozens of highly developed fibrous and synthetic rubber compositions—each distinctly classified by SAE-ASTM specifications . . . each a superior sealing element in recommended applications.

Technical counsel is available without obligation. Whether you specify packings in sheets or finished gaskets, your product can have the advantage of Victor's leadership in sealing engineering—without added cost.

There's a Victor Field Engineer in your area—or contact the home office. Victor Mfg. & Gasket Co., P.O. Box 1333, Chicago 90, Ill.

YOUR COMPLETE GUIDE TO GASKET MATERIALS—Victor Engineering Catalog No. 505. If you don't have a copy, please request one on your letterhead.

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VICTOR
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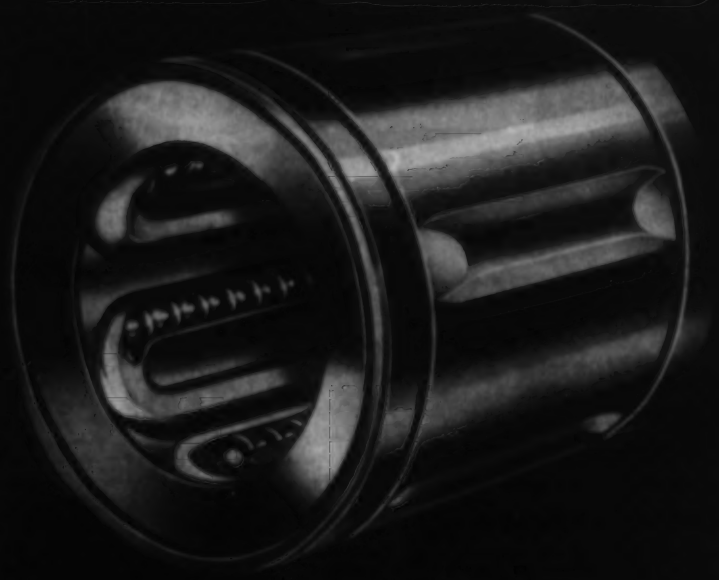
VICTOR

"ORIGINAL EQUIPMENT"
GASKETS • OIL SEALS • PACKINGS
SEALING PRODUCTS EXCLUSIVELY

BALL BUSHING



The BALL BEARING for your

LINEAR MOTIONS

Sliding linear motions are nearly always troublesome. Thousands of progressive engineers have solved this problem by application of the Precision Series A or Low-Cost Series B BALL BUSHINGS.

Alert designers can now make tremendous improvements in their products by using BALL BUSHINGS on guide rods, reciprocating shafts, push-pull actions, or for support of any mechanism that is moved or shifted in a straight line.

Improve your product. Up-date your design and performance with BALL BUSHINGS!

Now manufactured for ¼", ½", ¾", 1", 1½", 2", 2½", and 3" shaft diameters.

LOW FRICTION • LOW MAINTENANCE
ELIMINATES BINDING AND CHATTER
SOLVES SLIDING LUBRICATION PROBLEMS
LONG LIFE • LASTING ALIGNMENT

Progressive Manufacturers Use Ball Bushings —A Major Improvement at a Minor Cost

THOMSON INDUSTRIES, Inc.

Dept. E, MANHASSET, NEW YORK

Write for descriptive literature and the name of our representative in your city.

Also manufacturers of NYLINED Bearings — DuPont NYLON within a metal sleeve—for rotation and reciprocation.

New Parts

and will always provide a positive seal on reassembly. One-piece chrome molybdenum steel sleeve, slotted at one end, grips the tube and absorbs vibration. The solid end of the sleeve presses into the flared mouth of the connector body when the nut is tightened. Flow of fluid through tubing at the joint is full and unrestricted, because connection can be made only to tubing which is free from collapsed walls and inside burrs. Fitting can be used at pressures to 20,000 psi or more and is available in sizes to fit ⅛ to 2-in. OD tubing. Made by **Flodar Corp.**, 1366 E. 45th St., Cleveland 3, O.

For more data circle MD-82, Page 215

Cartridge Roller Bearing

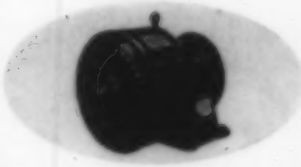
Assembled and self-contained Flexi-Flange cartridge roller bearing is installed with only a hand drill and wrench. Housed in a flexible neoprene housing, it is of steel cage construction. Misalignment of at least 1 degree between shaft

and housing is possible. Shaft size range is ½ to 1 7/16 in. Smallest size supports radial load of 415 lb at 100 rpm, while largest size has a capacity of 1665 lb at the same speed. Made by **Rollway Bearing Co.**, 541 Seymour St., Syracuse 4, N. Y.

For more data circle MD-83, Page 215

Rotary Actuators

Series 249 ten-pound rotary actuators for aircraft can handle ultimate loads up to 17,000 lb-in. and maximum operating loads up to 12,000 lb-in. Envelope size of the largest actuator in the series measures approximately 3¾ x 6¼ in. Without changing the basic configura-

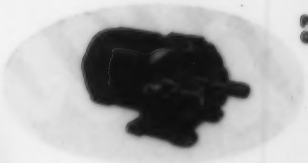


Torq-Master, used with torque converters and fluid couplings in the lumber industry

Giant gear and rack

Right angle vertical pump drive

Miniature motor. One of more than 50 basic designs



Pacific, G-E gearmotor

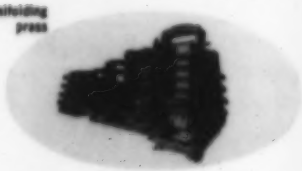
look to

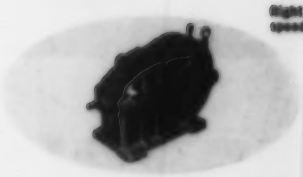
WESTERN GEAR for

- custom engineering
- specialized machinery for every purpose
- complete line of electro-mechanical catalog products
- gears of all types and sizes

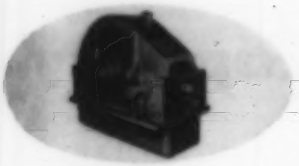
Illustrated are only a few of the wide variety of both custom and standard products designed and manufactured by Western Gear

Manifolding press



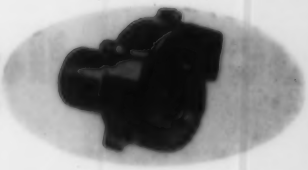


Right angle speed reducer



High speed unit

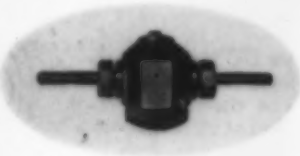
Centrifugal blower, one of many design sizes



Helicopter rotor drive unit

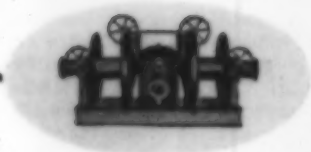
Sea-Master marine gear

Miniature precision differential unit



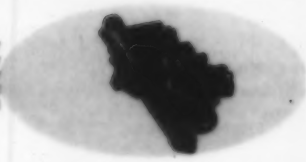
Aircraft cable drum type hoist, hydraulic, pneumatic or electric drive

Travel winch



Rotary actuator powered by both hydraulic and electric motors. One of hundreds of basic designs

Horizontal stabilizer actuator unit. AC and DC power providing three speeds for manual, auto pilot and coarse control



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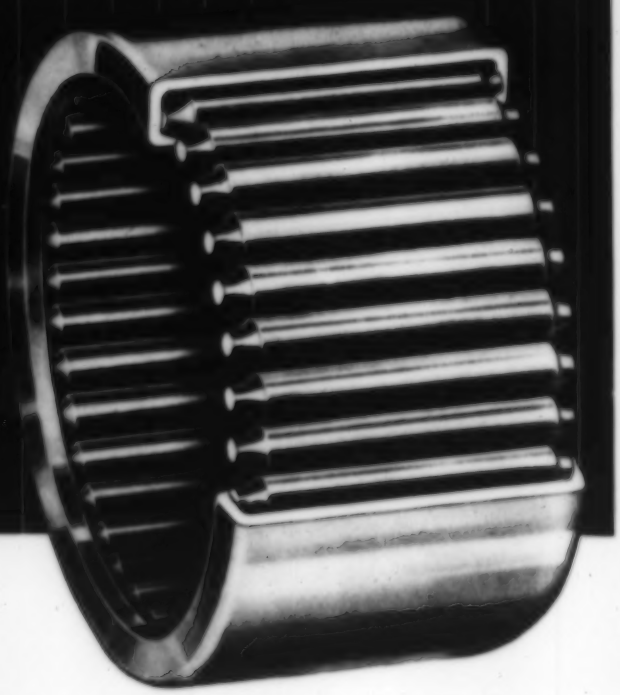
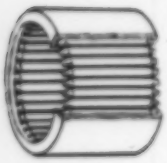
here's why...

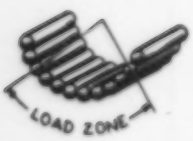


TORRINGTON

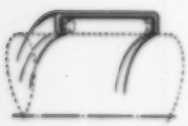
DC needle bearings give high-capacity performance in minimum space



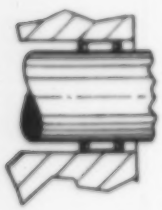
Unique construction—accurately drawn, surface-hardened shell retains rollers and serves as outer raceway.



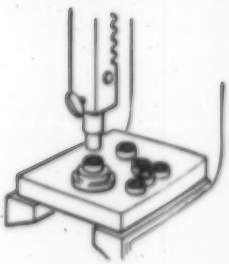
Full complement of small diameter rollers—precision-ground and through-hardened—assures top capacity by distributing load over large number of contacts.



Turned-in lips of the case-hardened outer shell keep dirt and grit out, lubricants in—while retaining trunnion ends of rollers. All wear surfaces of outer race are case-hardened.



No inner race required on surface-hardened shafts—reduces space requirements, lowers unit costs.



Simple assembly—arbor press seats bearing in round housing bore. No collars, shoulders or retaining rings needed.

Closed end type DC Needle Bearings are available for stub shaft applications. The closed end provides a perfect seal at no extra cost.

Needle Bearings are made in a Precision Series for most applications and an Extra Precision Series where low radial play and minimum eccentricity are required. Easy lubrication through optional hole in shell or through hole in shaft assures long service life. Bearings can be pre-packed with suitable grease for those applications requiring grease lubrication.

See our new Needle Bearing Catalog in the 1955 Sweet's Product Design File—or write direct for Catalog No. 55.

THE TORRINGTON COMPANY
Torrington, Conn. **South Bend 21, Ind.**

District offices and distributors in principal cities of United States and Canada

TORRINGTON NEEDLE BEARINGS

Needle • Spherical Roller • Tapered Roller • Cylindrical Roller • Ball • Needle Rollers

tion, a wide output range is made available by using interchangeable gear stages. Gear ratios range from 4.8:1 to 7,500,000:1. Design includes a load-limiter which de-energizes the unit when the output load exceeds a predetermined value and, upon relief of the overload, re-energizes the actuator to complete the stroke. Load limits are externally adjustable within the unit's operating range. Operating range of the load-limiter is also variable by means of interchangeable springs. Made by **Lear Inc.**, 110 Ionia Ave., N. W., Grand Rapids 2, Mich.

For more data circle MD-84, Page 215

Limit Switch

Designed for use in small appliances, office machinery and other devices which must operate on either ac or dc, this limit switch is approved by Underwriters' Laboratories for 3 amp, 125 v. The trip point repeats within a 0.010-in.

tolerance, and the switch has a movement differential of less than 0.060-in. Mountings can be supplied to suit individual requirements. Made by **Pass & Seymour Inc.**, Appliance Switch Div., Solvay Station, Syracuse 9, N. Y.

For more data circle MD-85, Page 215

Adjustable-Speed Transmission

Speeds from 7500 rpm to zero are obtainable from model 30MS5 adjustable-speed transmission designed for such diverse applications as tachometer testers, small generator drives and test equipment.

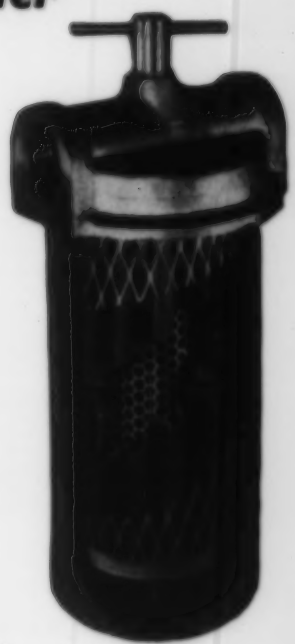
(*Continued on Page* 240)

MARVEL Synclinal FILTERS

For Efficient Filtration of—
Hydraulic Oils
Fire Resistant Hydraulic Fluids
Coolants — Lubricants
Water

SUMP TYPE (cutaway)

OVER 600 Original Equipment Manufacturers Install Marvel Synclinal Filters as Standard Equipment



LINE TYPE (cutaway)

PROTECT EQUIPMENT
INCREASE PRODUCTION
REDUCE MAINTENANCE

Marvel Synclinal Filters installed in the sump or on the line preceding pump offer maximum protection on all hydraulically actuated and other equipment utilizing low pressure circulating oil systems. Maintenance and production costs are reduced because Marvel Synclinal Filters BALANCED design offers greater ACTIVE filtering area with sufficient storage capacity for filtered out damaging particles, thus, longer periods of productive operation are attained at minimum "down time" due to maintenance and repairs.

PRODUCTION ENGINEERS and MAINTENANCE MEN whose job it is to keep production machinery operating at peak efficiency and who have recognized the superiority of Marvel Synclinal Filters in the filtration of hydraulic oils, fire resistant hydraulic fluids, coolants, lubricants, etc. are specifiying Marvel Synclinal Filters on all new equipment and standardizing with Marvel Synclinal Filters on all machines within their plants.
Another outstanding reason for their preference is the simple construction of Marvel Synclinal Filters which allows them to be easily disassembled, thoroughly cleaned and reassembled on the spot, by any workman in a matter of minutes. Line type operates in any position and may be serviced without disturbing pipe connections.

A SIZE FOR EVERY NEED
Available for sump or line installation in capacities from 5 to 100 G.P.M. Greater capacities may be attained by multiple installation (as described in catalog). Choice of Monel mesh sizes range from coarse 30 to fine 200.

IMMEDIATE DELIVERY!
As in the past, Marvel continues to offer Immediate Delivery!

VISIT OUR EXHIBIT
Booth #809
at the
PRODUCTION ENGINEERING SHOW
Navy Pier—
Chicago, Ill.
SEPT. 6 to 16

See MARVEL SYNCLINAL FILTERS in Action!

Catalogs containing complete data available on request

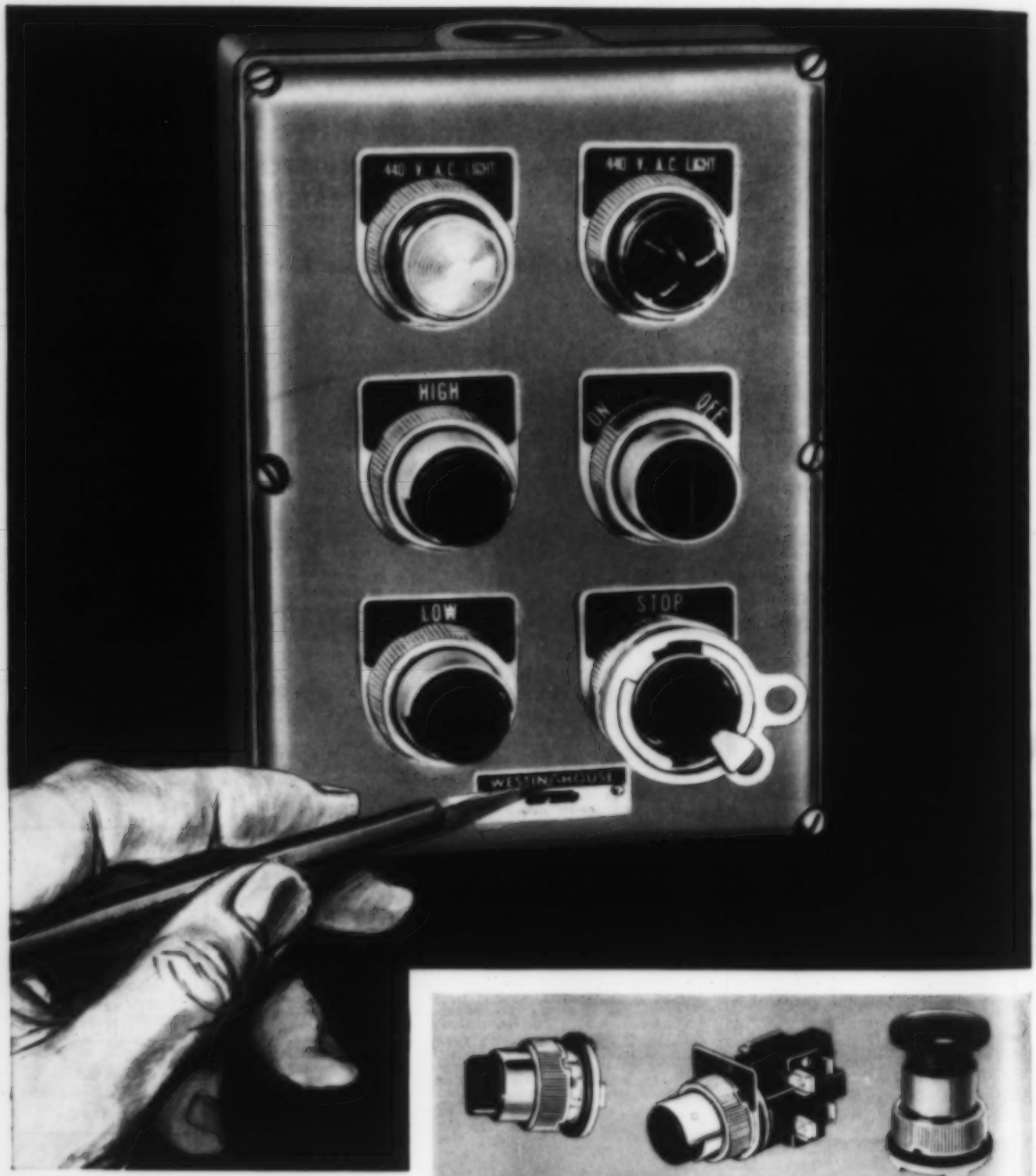
MARVEL ENGINEERING COMPANY
625 W. Jackson Blvd., Chicago 6, Ill.
Phones: FRANKLIN 2-3530 & FRANKLIN 2-4431

MD-8

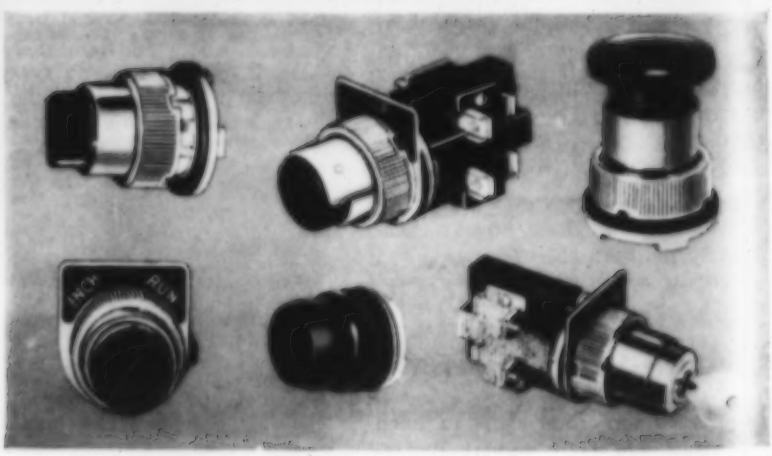
Without obligation, please send me complete data on Marvel Synclinal Filters, as indicated:—

☐ Catalog No. 196—For Hydraulic Oils, Coolants and Lubricants
☐ Catalog No. 300—For WATER
☐ Data on filters for Fire-resistant hydraulic fluids.

Name .....
Title .....
Company .....
Address .....
City .....
State .....



Westinghouse 6-Unit Oil-Tite* Control Station



Greater Unit Flexibility for Oil-Tite pushbuttons is provided by many types of operators. Oil-Tite controls available in one to twelve unit stations. The die-cast gasketed oiltight enclosure is impervious to water, oil, coolant, cutting compounds and dust.

Here's why Westinghouse control stations increase pushbutton flexibility

Industry's Most Complete Line offers a wide selection of components for every pushbutton application—standard duty, heavy duty, oiltight, pendent type and special service.

Standardized Components provide greater application flexibility—help you benefit from off-the-shelf shipments and smaller inventories. The simple combination of a few interchangeable component parts gives you the right pushbutton or selector switch for every application or service requirement.

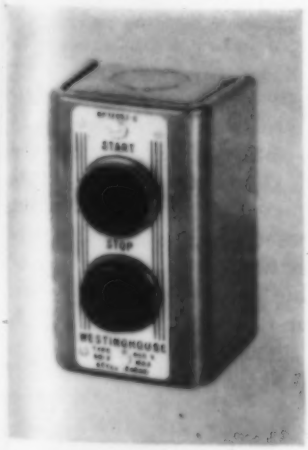
Special Features like these save you time and money: double-break, solid silver contacts—complete selection of interchangeable operators—large buttons for easier, more certain operation—shroud shielded buttons protect against accidental operation—double knockouts, top and bottom, for easier wiring—finest available materials.

Enclosures for Every Application—surface or flush mounting, indoor or outdoor, water and dust-tight, oil immersed, die-cast gasketed oiltight, and pendent mounting.

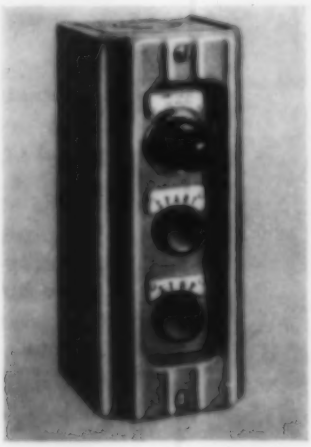
Why not investigate the advantages of standardizing on all your pushbutton needs with Westinghouse control stations? Get the full story from the control sales engineer at your nearest Westinghouse office, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-30189

*Trade-Mark

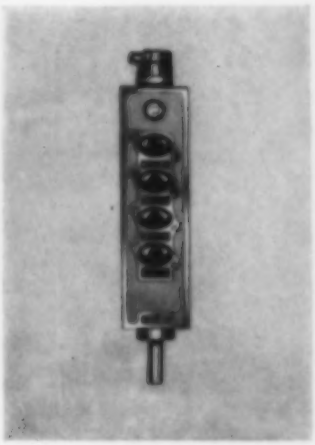
YOU CAN BE SURE... IF IT'S Westinghouse



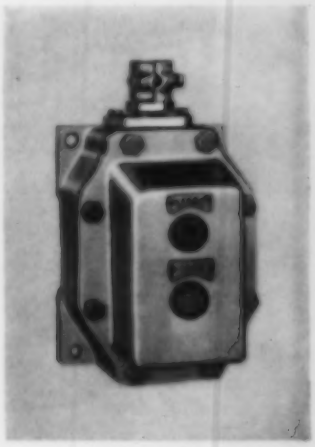
Standard-Duty pushbuttons are available in a choice of one-, two- and three-unit stations.



Heavy-Duty surface mounting stations offer a variety of enclosures—a wide range of accessories.



Pendent-Type stations are available in standard, heavy-duty and Oil-Tite enclosures.

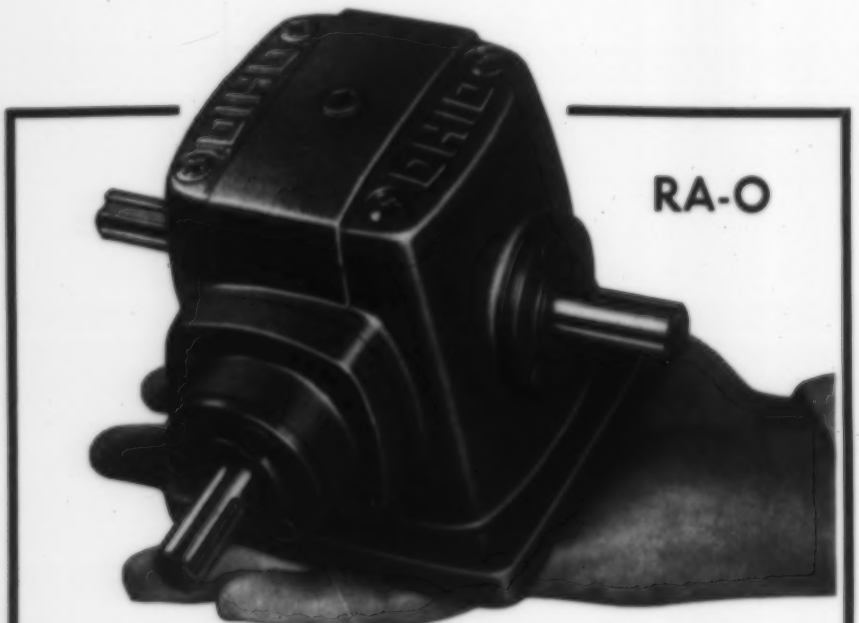


Special-Service pushbuttons available for mining, steel mill and other extra-heavy-duty applications.

OHIO

Here is Ohio Gear's new redesigned "baby" speed reducer, the horizontal double reduction 1/6 horsepower DOX. This sturdy and efficient unit has a modern zinc alloy housing, available in ratios of 4:1 to 1600:1, with torque capacities of 25 to 150 inch pounds. The DOX has a definite place in the fields of animated displays, home work shops, conveyors, barbeques, and domestic stokers.

Another recent addition to the right angle line is the compact RA-O. The capacity of this bevel gear unit supplements those of the RA-2 and RA-4; the new RA-O has ⅝" shafts and standard ratios of 1:1, 2:1, and 3:1 with ratings of 2, 1½ and 1 Horsepower, respectively, at 1800 RPM input speed. Assemblies available with output shaft vertically up or down, or both.



ESTABLISHED 1915

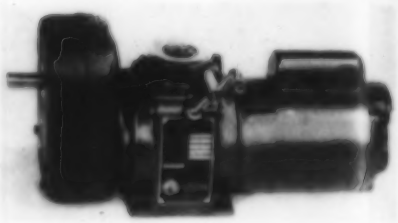
OHIO GEAR COMPANY

OHIO GEARS

1338 E. 179th ST.
CLEVELAND 10, OHIO

New Parts

(*Continued from Page 237*)



Delivered torque increases as speed increases. Micrometer control over entire speed range is standard. Entire assembly, consisting of motor and drive, can be mounted with only four bolts. Transmission can be obtained without motor, or with one of many types of built-in motors, as well as with a variety of reducer assemblies. Made by **Graham Transmissions Inc.**, Menomonee Falls, Wis.

For more data circle MD-86, Page 215

Magnetic Counter

With switch lever up, series 1520 magnetic counter adds; with switch down, it subtracts. Counter has two coils and an actuating means. Coils for 24, 48, 110 and 220-v ac or dc operation are available. White plastic wheels have 0.188-in. high black figures. Counter can be

actuated by any type switch, relay or photoelectric unit, either to add or to subtract. Dimensions are 4¼ x 2¾ x 3 in. Counter is available with three, four, five or six figures, reset or nonreset. Operating speeds of 700 counts per minute and higher are possible. Made by **Veeder-Root Inc.**, Hartford 2, Conn.

For more data circle MD-87, Page 215

Hydraulic Cylinder Packings

Chemically inert Teflon piston cup, U-cup and flange packings provide protection against the cor-

ONE OF A SERIES

You Get Many Benefits
By Specifying VICKERS Hydraulics

Reduced Maintenance Costs

Vickers Oil Hydraulic Equipment is built to minimize maintenance . . . has an outstanding performance record. Nevertheless, Vickers recognizes that sooner or later any piece of machinery requires overhaul. So we have developed a service department of exceptional efficiency . . . one that is convenient for you by reason of full time factory-trained service men working out of our offices from coast to coast.

Shown below are several of the practical aids provided to assure you quick and economical service on Vickers Hydraulics.

VICKERS Incorporated
DIVISION OF SPERRY RAND CORPORATION
1430 OAKMAN BLVD. • DETROIT 32, MICH.
Application Engineering Offices: • ATLANTA CHICAGO AREA (Brookfield) • CINCINNATI • CLEVELAND • DETROIT • HOUSTON • LOS ANGELES AREA (El Segundo) • MINNEAPOLIS • NEW YORK AREA (Summit, N. J.) • PHILADELPHIA AREA (Media) PITTSBURGH AREA (Mt. Lebanon) • ROCHESTER ROCKFORD • SAN FRANCISCO AREA (Berkeley) SEATTLE • ST. LOUIS • TULSA • WASHINGTON WORCESTER

SPARE PARTS RECOMMENDATIONS

Our service men will study your situation and make practical recommendations on your spare parts inventory . . . will check your inventory and provide you with printed lists of parts usually required.

SERVICE KITS

Packaged repair kits for many Vickers products are available. These provide all needed parts for quick repair in the field and at minimum cost. In addition, these kits simplify stock problems by reducing the number of loose parts.

PREVENTIVE MAINTENANCE

Our service men will gladly set up for you an effective program of preventive maintenance on a timetable basis. This avoids costly down time and keeps maintenance costs at a minimum.

SERVICE SCHOOL

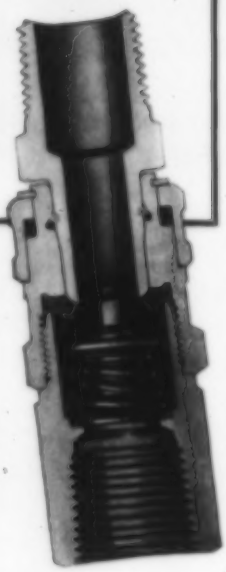
Vickers maintains a Hydraulics Training School for engineering, maintenance and service personnel of both original equipment manufacturers and their customers. For further information, please contact Product Service Department directly.

7143

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

Everything You Want

in a Quick-Connective Pneumatic Coupling



HANSEN SERIES 3-RL

RING-LOCK COUPLING

- Smaller.
- Lighter.
- Effectively handles more volume than any other coupling of equal dimensions.
- Handles any job with fittings from ¾" to ⅛", from the air line to the air tool.
- All Series 3-RL Sockets and Plugs are interchangeable — reduces stock inventory to a minimum.
- One-way shut-off—for pneumatic service applications.
- Positive locking.
- Equipped with automatic sleeve lock.

Compactly designed, the Hansen Series 3-RL Coupling *effectively* handles far more volume than any coupling of equal dimensions. On any job requiring ¾" to ⅛" connections—from the air line to the air tool—this single size Hansen Ring-Lock Coupling – with completely interchangeable Sockets and Plugs – does it all – makes it easy to keep stock of parts in balance—holds inventories to a minimum.

To connect the Series 3-RL Coupling, you merely push the Plug into the Socket. To disconnect, just turn the sleeve. When Coupling is connected, a locking ring in Socket enters groove in Plug, provides positive lock and insures tight fit. Sockets with aluminum bodies are available for use with small hand-operated air tools.

Relative size of ordinary coupling required for effective handling of same volume

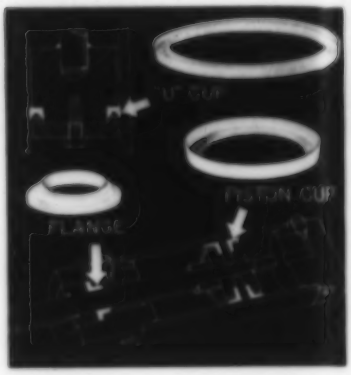
Write for Descriptive Literature

SINCE 1915 • QUICK CONNECTIVE FLUID LINE COUPLINGS

THE HANSEN MANUFACTURING COMPANY

4031 WEST 150th STREET • CLEVELAND 11, OHIO

New Parts

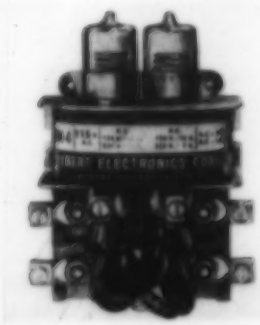


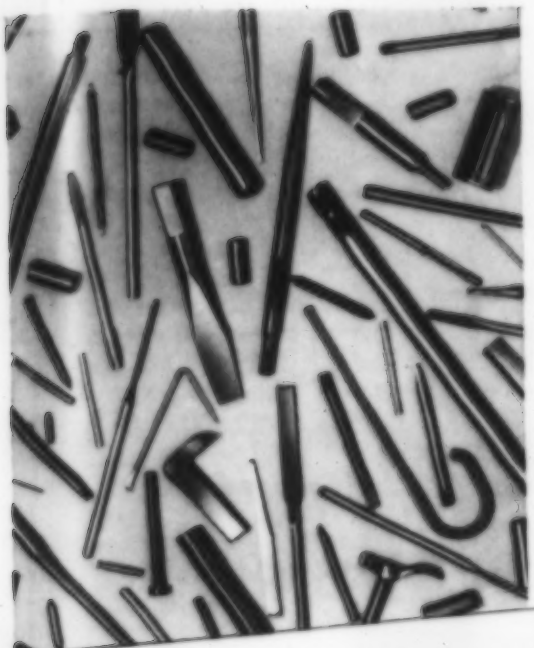
rosive action of all types of synthetic nonflammable fluids. They will withstand temperatures to 350 F and are self-regulating to compensate for pressure. Piston cup packings are available in a standard range of cup sizes from 1 to 12 in., or to specifications. They are recommended for pressures to 2000 psi. U-cup packings are furnished to piston or cylinder specifications, for pressures to 1500 psi. Flange packings are made to specifications for pressures to 2000 psi. Made by **Crane Packing Co.**, Dept. MDC, 1800 Cuyler Ave., Chicago 13, Ill.

For more data circle MD-88, Page 215

Mercury Relay

Redesign of two-pole, single-throw mercury relays incorporates a collar which supports the relay tube itself. A tamper-proof self-closing spring clamp replaces screw type clamp. The bottom set of compression type connectors can be placed in either vertical or horizontal position for easier load connection. Aluminum cups hold mercury. Contacts are completely enclosed in hermetically sealed tubes for safe operation in explosive, corrosive or outdoor atmospheric conditions. Cotton interwound coils





One hundred or a million . . . **TORRINGTON** *small precision parts are exactly alike*

Precision and uniformity go hand in hand at Torrington—regardless of the size of the order.

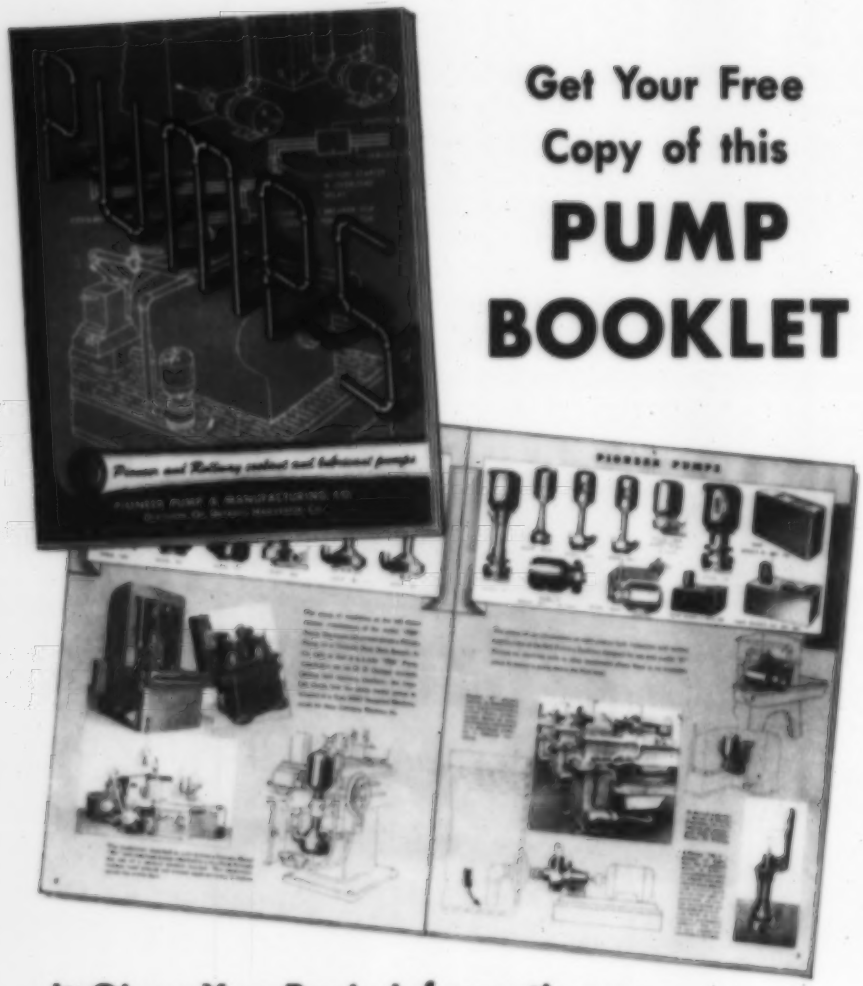
Automatic equipment of special design, and the know-how gained in almost 90 years of precision metalworking enable us to produce your small precision parts to the highest standards of uniformity.

Let us produce a trial order for you. Send your blueprint or a sample part for our prompt quotation. Ask for our Condensed Catalog. It shows many of the parts we can make *faster, better and for less* than you can yourself.

THE TORRINGTON COMPANY
Specialties Division
110 Field Street, Torrington, Conn.

TORRINGTON *SPECIAL* **METAL PARTS**

Makers of Torrington Needle Bearings



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PUMP BOOKLET

It Gives You Basic Information on

PIONEER
Centrifugal
and
ROLLWAY
Positive
Displacement
PUMPS
for Coolants, Lubricants, and Abrasive Liquids

•

Send for Your Copy

An introduction to Pioneer's complete line of 400 models—developed through 23 years as a specialist in Centrifugal and Positive Displacement pumps. Illustrated are some 40 Pioneer and Rollway models, together with numerous application pictures and a description of the features of basic pump types.

Pioneer pumps offer manufacturers many advantages, including the saving effected through the selection of standard pumps to meet custom requirements—plus an unusual opportunity for standardization and interchangeability.

Pioneer application engineers will welcome the opportunity to discuss your pump requirements with you.

PIONEER PUMP DIVISION
DETROIT HARVESTER COMPANY
5450 West Jefferson Ave • Detroit 9 Michigan

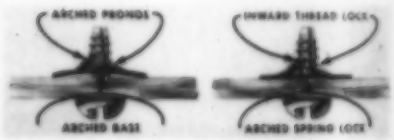
New Parts

are impervious to dust, dirt and moisture. Contacts may be had either both normally open or normally closed. Model EM-4, illustrated, is rated at 35 amp or 2 hp at 115 v, ac. Heavy-duty type HD-4 is rated at 60 amp at 115 v, ac. The dc ratings of both models are 12 amp at 120 v and 7 amp at 220 v. Made by **Ebert Electronics Corp.**, 212-26 Jamaica Ave., Queens Village 28, N. Y.

For more data circle MD-89, Page 215

Self-Locking Fasteners

Self-locking, flat type C7000 series Speed Nut accommodates either A or B (Z) sheet metal screw threads. The vibrationproof fasteners are made in one piece of spring steel. They spin freely down

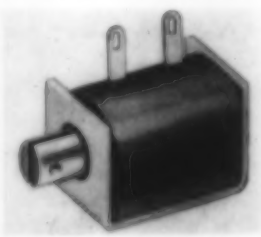


the screw threads, with the base arch of the nut flattening with one or two final turns to force its prongs into the roots of the threads. Made by **Tinnerman Products Inc.**, Dept. 14, P. O. Box 6688, Cleveland 1, O.

For more data circle MD-90, Page 215

Miniature Solenoid

The shading coil of this compact, lightweight solenoid is embedded in the plug for high efficiency and high seated pull. Solder terminals are standard, but the solenoid can be furnished with flexible leads.



Engineered to a particular application, it is factory tested for breakdown, continuity, current pull and dimensional accuracy. Regularly rated at 115 v, 60 cycles ac,

Sealtite resists corrosive mixture of powdered calcium sulphate, magnesium oxide and magnesium chloride.

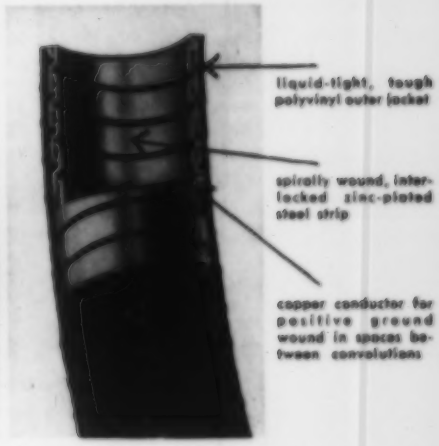
Sealtite protects grinder motor leads . . . flexes continuously under abrasive coat of metal dust, oil and coolant.

In paper mill's steamy air, Sealtite is covered with oil and wet pulp containing chlorine and caustic soda.

Give the dirtiest jobs to SEALTITE flexible, liquid-tight conduit

Sealtite makes tight bends on hydraulic press, keeps motor leads free from oil, grease and water.

Sealtite keeps weather out of leads to outdoor pump motor.


liquid-tight, tough polyvinyl outer jacket
spirally wound, interlocked zinc-plated steel strip
copper conductor for positive ground wound in spaces between convolutions

Cutaway shows construction details of Sealtite Type UA.

Sealtite is made in two types. Specifications in table below. Type UA is approved by Underwriters' Laboratory for service in wet spots. Available in light gray as well as black.

Type EF† meets JIC standards. Extra flexible . . . ideal for machine tool applications. Standard stock colors: black, and machine tool light gray at no extra cost.

SEALTITE TYPE E. F.

Trade Size (In.)	INSIDE DIAMETER (Inches)		OUTSIDE DIAMETER (Inches)		Appr. Inside Bend Diam. (In.)	Est. Wgt. (Lbs. Per 100 Feet)	Feet Per Std. Coil
	Min.	Max.	Min.	Max.			
⅜	.485	.505	.690	.710	5	24.0	250
½	.620	.640	.820	.840	6	29.0	200
¾	.815	.835	1.030	1.050	9	38.5	200
1	1.030	1.055	1.290	1.315	10	68.0	100
1¼	1.370	1.395	1.630	1.655	13	86.0	100
1½	1.575	1.600	1.875	1.900	15	117.0	50
2	2.020	2.045	2.350	2.375	17	155.0	50
2½	2.480	2.505	2.850	2.875	20	198.0	—
3	3.070	3.095	3.470	3.500	27	282.0	—
4	4.000	4.050	4.465	4.500	34	414.5	—

SEALTITE TYPE U. A.

Trade Size (In.)	INSIDE DIAMETER (Inches)		OUTSIDE DIAMETER (Inches)		Appr. Inside Bend Diam. (In.)	Est. Wgt. (Lbs. Per 100 Feet)	Feet Per Std. Coil
	Min.	Max.	Min.	Max.			
⅜	.484	.504	.690	.710	8	30.0	200
½	.622	.642	.820	.840	10	36.6	200
¾	.820	.840	1.030	1.050	15	48.2	150
1	1.041	1.066	1.290	1.315	18	87.7	100
1¼	1.380	1.410	1.630	1.660	21	116.5	50

Sealtite* flexible, liquid-tight conduit gives wiring maximum protection against oil, grease, water, dirt, chemicals, corrosive atmospheres and weather. Nothing gets through its tough, polyvinyl outer covering. It stands up under continuous flexing . . . absorbs vibration, connects moving parts . . . connects misaligned outlets . . . prevents burn-outs. For long runs or short leads it's easy to install . . . saves the time it would take you to cut, bend and fit rigid conduit.

ELECTRICAL WHOLESALERS stock Sealtite in easy-to-handle coils. Buy it this way in long lengths . . . cut it on the job without waste. Your electrical wholesaler also stocks liquid-tight connectors. For more information write for Sealtite bulletins. Address *The American Brass Company, American Metal Hose Branch, Waterbury 20, Conn.*

*Trade Mark
†Pat. App. For

SEALTITE FLEXIBLE, LIQUID-TIGHT CONDUIT

AN **ANACONDA®** PRODUCT

DESIGNERS

Mail this Coupon
if you want an
opportunity to grow

NAME _____

ADDRESS _____

CITY _____ STATE _____

Check your DESIGN EXPERIENCE in these (or related) fields:

- ☐ Compressors
- ☐ Turbines
- ☐ Structures
- ☐ Afterburners and Related Equipment
- ☐ Aerodynamics
- ☐ Hydraulics
- ☐ Gears
- ☐ Valves
- ☐ Heat Exchangers and Combustion Problems
- ☐ Bearings
- ☐ Piping
- ☐ Controls
- ☐ Test Equipment
- ☐ Test Rigs
- _____
- _____
- _____
- _____

Total years Mechanical Design experience _____

We may want to call you by telephone. So please give phone no. _____ and best hours for receiving calls _____.

Mail *immediately* to Mr. P. R. Smith, Dept. 4, Design Employment.

GOOD FUTURES FOR MEN OF ABILITY!

There is constant creative challenge in the development of aircraft engines — turbojet, turboprop, nuclear. Frequently our designers are working beyond the extreme limits of current technical knowledge — exploring, pioneering to solve problems of weight, stress, vibration.

Our work requires good men — but it *makes* good men, too.

Thus, if you meet our qualifications, you'll have every opportunity to use your abilities to the utmost. If you have superior ability — or can develop it — there's no limit to your future. Rest assured, we'll encourage your professional growth — recognize and reward it.

NOT AN IMPERSONAL MASS-PRODUCER!

In a financial sense Pratt & Whitney Aircraft is *big* — strong, well-financed, the world's foremost designer and builder of aircraft engines. Yet it is not an impersonal, sprawling, industrial giant. It is primarily a design and development organization not a mass producer.

Because of this P&WA offers the small company environment so desired by most engineers — the ingredients of friendliness, helpfulness, encouragement that make for a secure and happy life.

Yet at the same time it offers you and your family all the benefits characteristic of a big company — many employee help plans, attractive salary levels, unexcelled facilities. And, of course, it offers New England living with all that this implies in cultural advantages, good schools, a pleasant life in suburban areas.

There's a real future here. So *mail* the coupon today. At Pratt & Whitney Aircraft there's always plenty of opportunity for men who want to grow in professional standing.

PRATT & WHITNEY AIRCRAFT
DIVISION OF UNITED AIRCRAFT CORPORATION
EAST HARTFORD 8, CONNECTICUT

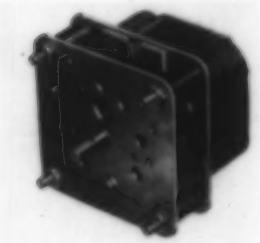
New Parts

it is available on order for any other ac voltage and frequency. The solenoid operates in any position. Made by **Dormeyer Industries**, Dept. MDC, 3418 N. Milwaukee Ave., Chicago 41, Ill.

For more data circle MD-91, Page 215

Open Type Gearmotor

This open type gearmotor for overhanging or radial thrust loads is offered with starting torques up to 75 lb-in. and gear ratios from 4:1 to 30,000:1. Motor has double-supported gear shafts running in sintered bronze bearings, heavy duty gears and output shaft, and

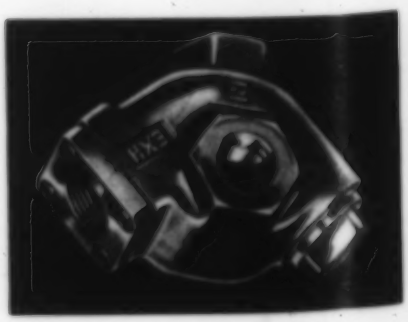


helical pinion and gear in the first step. Synchronous, nonsynchronous unidirectional, or nonsynchronous reversible motors are available. Applications include vending machines, recording instruments, timers, office machines and appliances. Made by **Barber-Colman Co.**, Small Motors Div., 1300 Rock St., Rockford, Ill.

For more data circle MD-92, Page 215

Quick-Exhaust Valve

This oversized exhaust opens automatically upon reversal of the main operating valve, permitting almost instant discharge of exhaust at the cylinder. Four models are available, with pipe sizes of ⅜, ½, ¾ and 1 in. Pres-



PRODUCT SALEABILITY IS A BASIC REQUIREMENT OF SUCCESSFUL DESIGN

Resistance welding helps you improve your product design

STRENGTH

Resistance welds are stronger than either of the metals welded together. After 10 years of exhaustive tests no other joint survived, practically all automobile manufacturers have adopted resistance welded wheels. The wheels are made with 8 spot welds instead of the 12 conventional rivets . . . using Sciaky equipment.

RESISTANCE TO CORROSION

Resistance welding leaves no exposed metals to corrode, because the weld is within the metals. There are no holes and the joint is tight. However, tight fit-up cannot always be maintained for riveted joints or rivet heads. The result is penetration of atmospheric moisture and corrosion.

LACK OF DISTORTION

Properly applied, resistance welding practically eliminates warpage and distortion. Thus, costly jigs and fixtures to reduce distortion are not necessary on products designed for resistance welding. However, fusion welding produces considerable distortion and does require the extra expense of related fixturing.

LEAKPROOF

With resistance welding there is no hole . . . thus it is leakproof. Actually, resistance welding is commonly used to make gastight seams. However, riveted assembly is inherently subject to leakage. Not only costly to make leakproof, it is sometimes even impractical.

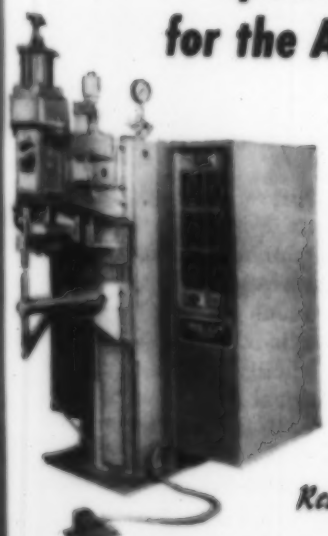
REDUCTION OF WEIGHT

Nothing is added to make a resistance weld—no rod, flux, rivets, etc., are needed. The parent metals themselves are fused together. Resistance welding a product provides a considerable savings in weight compared to riveting, or other forms of welding.

IMPROVED APPEARANCE

Resistance welded spots can be made practically invisible. They need not mar exterior surfaces as do other forms of welding or riveting. Surfaces requiring smooth finish and attractive appearance are best designed for fastening with resistance welding.

Specify Sciaky Patented Three-Phase Resistance Welding for the Advantages of Economy and Consistent Weld Quality



Pioneered, invented, and patented by Sciaky, the three-phase principle of welder operation allows a balanced current to be drawn from all three phases of the power supply.

The result is the lower operating cost of reduced power demand . . . the lower installation costs of smaller switch gear and smaller distribution lines . . . and the consistency of suitable weld quality under high production conditions. For detailed explanation of these and other impressive advantages of Sciaky patented Three-Phase operation, write for Bulletin 332.

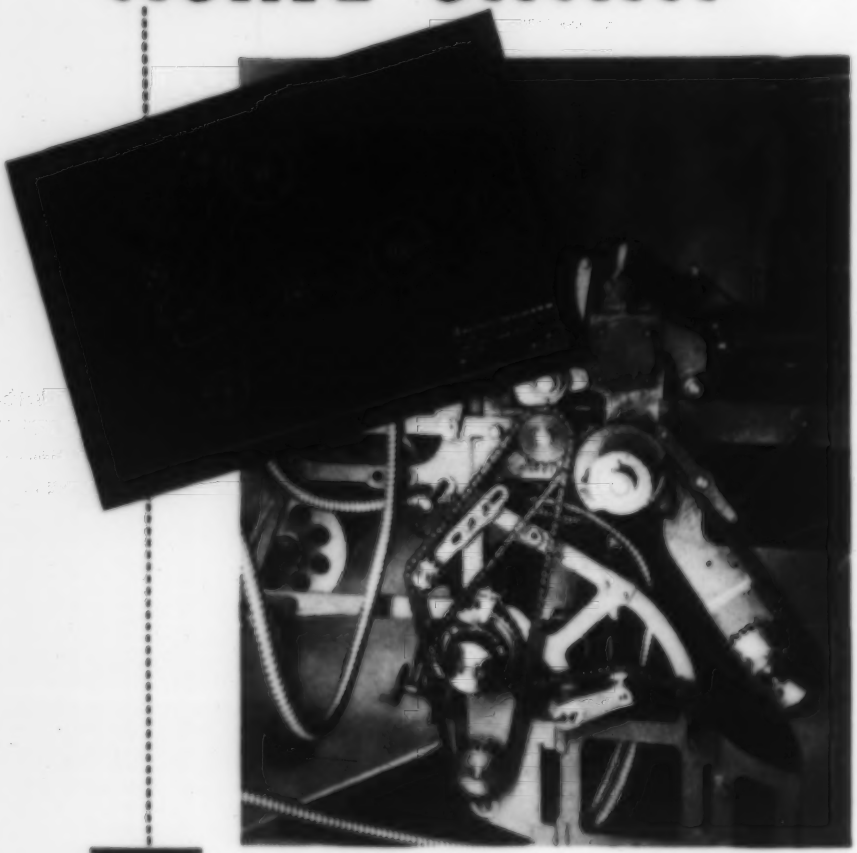
Detailed examples of Sciaky resistance welding applications are available in regular issues of "Resistance Welding at Work." Read how other companies large and small have improved their product and lowered fabricating costs. Send your name and title on company letterhead for these impressive examples of Sciaky's basic thinking—welders designed to do *more useful work* at *lower operating costs* with *maximum reliability*.

Largest Manufacturers of Electric Resistance Welding Machines in the World

SCIAKY®

Sciaky Bros., Inc., 4939 West 67th Street, Chicago 38, Ill., Portsmouth 7-5600

ACME CHAIN



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Write Dept. 6X for new illustrated 76 page catalog on use and application of roller chains and sprockets.

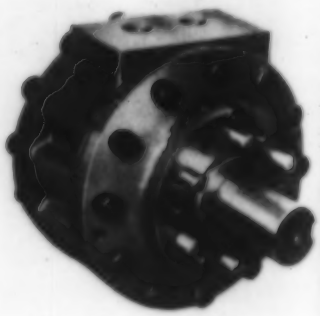
Acme Chain Corporation
HOLYOKE
MASSACHUSETTS

sure rating is 125 psi, and maximum recommended operating temperature is 175 F. Made by **Ross Operating Valve Co.**, 120 Golden Gate Ave., Detroit 3, Mich.

For more data circle MD-93, Page 215

Rotary Actuator

Roto Jack provides torque for revolving, opening, closing, lifting, pushing and pulling by means of reciprocating rotary power. It consists of a cylindrical housing, with caps at both ends, in which is mounted a rotating shaft with an attached vane. Hydraulic oil under pressure up to 1000 psi, or lubricated air under pressure, moves the vane. Shaft rotation is



limited to 300 deg in either direction by a stationary inside stop. Shaft speed is determined by the capacity of the fluid pressure source, usually a vane or gear pump. Magnitude of torque, which depends on the pressure exerted on the vane, is 10,000 lb-in. at 1000 psi. The unit can be faced mounted or, by the addition of a bracket, flange or foot-mounted. Double shaft extensions are available. Made by **American Engineering Co.**, Aramingo Ave. & Cumberland St., Philadelphia 25, Pa.

For more data circle MD-94, Page 215

Timing Motor

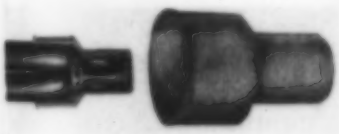
Right, left or oscillating shaft rotations are available on the type 113 synchronous timing motor. Torque rating is 30 oz-in. at 1 rpm. Motor runs equally well in any position. Cylindrical gear train is offered with 1, 2, 4 and 8-rpm output speeds. An eight-tooth shaft pinion is standard. Motor starts in-

stantly and stops within two cycles. Temperature rise is 43 C. Motor can be supplied for 115 or 220 v, 50 or 60-cycle operation. Size is 1 3/16 x 1⅞-in. Made in production quantities only by **R. W. Cramer Co. Inc.**, Centerbrook, Conn.

For more data circle MD-85, Page 215

Insulator

Quickly and easily installed, this nylon splice cap insulator protects spliced joints. It will not work loose even under conditions of extreme vibration. An internal metallic retainer ring permits snapping the insulator in place over a previously installed splice cap and



prevents accidental removal in service. Insulators are available in two sizes for use with two sizes of splice caps which accommodate normal circuit wiring from two No. 18 wires through three No. 8 or two No. 6 wires. Made by **Buchanan Electrical Products Corp.**, 225 Highway 29, Hillside, N. J.

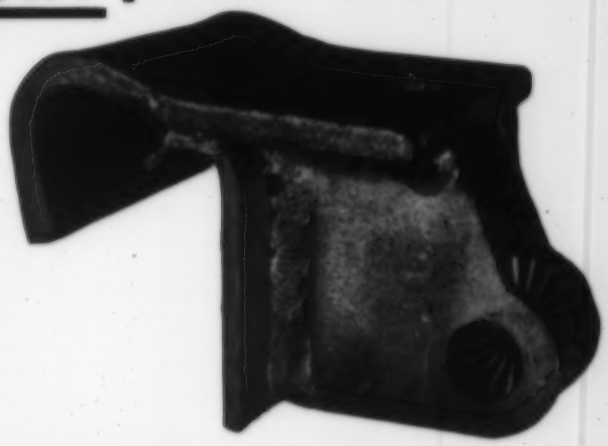
For more data circle MD-96, Page 215

Sponge Vinyl Plastisol

When subjected to 300 to 400 F for 3 to 30 minutes, a new plastisol produces a uniform vinyl sponge. It contains chemical blowing agents and is shipped as pourable liquid. Expansion of 100 to 600 per cent and densities from 8 to 30 lb per cu ft can be controlled. Plastisol can be used in making such products as rollers, gaskets, toys, sheeting, cushions, packing, insulation,

(*Continued on Page* 254)

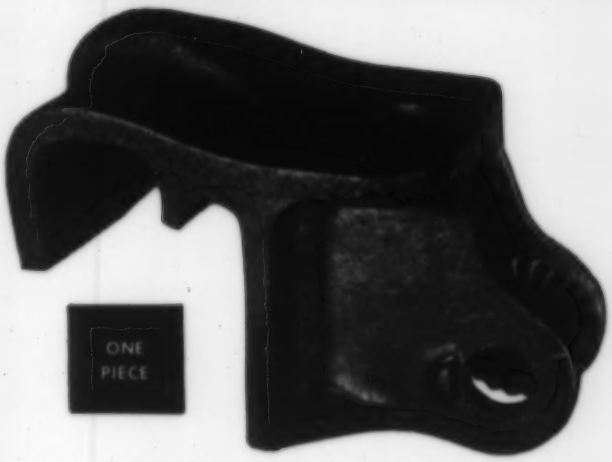
Why four pieces of metal?



. . . with necessary cutting, punching, forming and welding!

. . . How about

Malleable?



Stronger one piece malleable iron casting with better appearance

Better material selection exemplified by this trailer hitch is an everyday development in the malleable iron foundry industry.

The improved design, and therefore *appearance*, is quickly apparent. The big advantages are greater uniformity and dependability, and increased strength—*at lower cost* (in this case, 25% lower cost to the customer). The unit is completely stress relieved and benefits from a better distribution of metal than its fabricated predecessor. Improved damping properties and corrosion resistance are additional gains.

If you are not using malleable iron's remarkable properties, it will pay you to call a malleable foundry and go over your products with their engineers. Skilled in casting design, they show you how to save money and improve your products with Malleable Iron Castings.

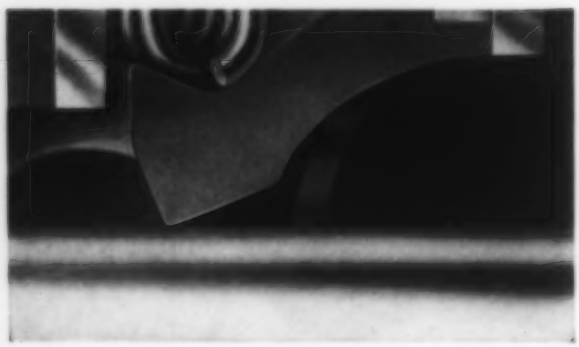
1800 Union Commerce Building **Cleveland 14, Ohio**

Be sure of

LOW LOW

with NATIONAL

Exclusive Syntech sealing lip cuts torque in half.

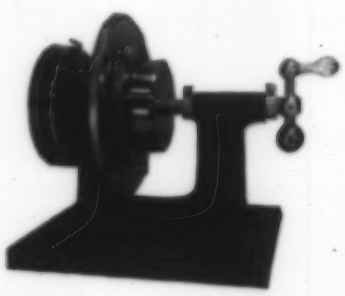


National Syntech® synthetic rubber seals are engineered for higher speeds and temperatures; applications where torque must be held to the absolute minimum. Syntech seals have unique sealing lip design to provide minimum contact between lip and shaft. This design reduces torque up to 50% over conventional sealing lips. Operation is cooler, service life is longer, and there is no measurable leakage. National Syntech seals are available with rubber covered or ground metal O.D.'s, and are unaffected by most industrial fluids.

National Micro-Torc oil seals employ a sealing lip of leather, surface coated with a high lubricity elastomer. The exceptional lubricity of

Shaft Size	Break Away Torque		Running Torque	
	Conventional Leather	Micro-Torc	Conventional Leather	Micro-Torc
1.500"	39 oz-in	7 oz-in	60 oz-in	36 oz-in
2.937"	126	39	253	184
3.812"	93	49	287	207

Micro-Torc's surface coating permits cooler running, "inside" oil storage, lower torque.



New, portable meters measure oil seal torque to 60 in. lbs.

TORQUE
TORQUE
TORQUE

OIL SEALS

this coating helps reduce torque as much as 80%, yet permits operation with no measurable leakage. Because the coating is surface only, the body of the sealing lip retains its inherent porosity to store oil for periods of semi-starved operation. Operation of Micro-Torc is cooler, and service life is materially longer.

National Torque Meters fill industry's need for a quick, accurate way to measure oil seal torque in standards determination, quality control and parts inspection. They provide laboratory accuracy, yet are rugged, fool-proof, easily used by anyone. Two models are offered: one measuring torque to 15 lb. in. on seals to 6" diameter and one measuring torque to 60 lb. in. on seals to 8" diameter.

Factory trained field engineers at your service

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DETROIT, MICH. . . . . *726 Lothrop Avenue, TRinity 1-6363*
DOWNEY (Los Angeles Co.), CALIF. . *11634 Patten Rd., TOpaz 2-8166*
INDIANAPOLIS, INDIANA . *2802 North Delaware St., WAlnut 3-1535*
MILWAUKEE, WIS. . . *647 West Virginia Street, BRoadway 1-3234*
NEWARK, N. J. . . *Suite 814, 1180 Raymond Blvd., MItchell 2-7586*
REDWOOD CITY, CALIF. . . *Broadway and National, EMerson 6-3861*
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• potentiometers
• connectors
• instruments

you're sure with **DeJUR** electronic sales division

New Parts

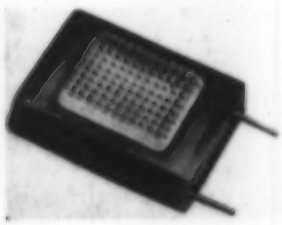
(*Continued from Page 251*)

and shock absorbers. It can be spread-coated, sprayed, molded, dipped or cast. Sponge is tough, flexible and nonshrinking, and will resist oxidation, oils, grease and most acids, alkalies and solvents. It can also be made flame resistant and flexible at low temperatures. Sound deadening and thermal insulating properties are good. Wide range of colors is available. Made by **Watson-Standard Co.**, 216 Galveston Ave., Pittsburgh 12, Pa.

For more data circle MD-97, Page 215

Photo-Conductive Cell

This photo-conductive cell, which handles power up to 0.3-w, eliminates the need for electronic amplifier, vacuum photocell and direct current power supply. It is designed to operate relays and other devices on voltages from 1.5 to 110 v with incident light values from

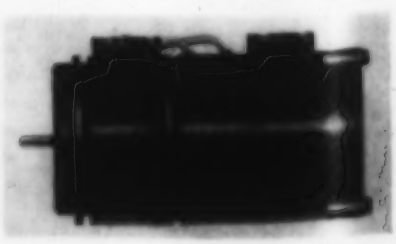


daylight (1000 ft-c) to moonlight (0.02-ft-c). Sensitivity is 0.4-amp per lumen, and it handles power up to 0.3 w. Made by **Canadian Marconi Co.**, 2442 Trenton Ave., Montreal 16, P.Q., Canada.

For more data circle MD-98, Page 215

Tachometer Feedback Unit

Miniature combination servo motor and ac tachometer generator that operates on 60-cycle current can be used to regulate the speed of a motor or to stabilize closed-loop circuits. Mounting of motor



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. . . tailor made to your specifications
1. YOUR section is preformed to the cross section of the part you wish to produce. The range of sections is practically unlimited.
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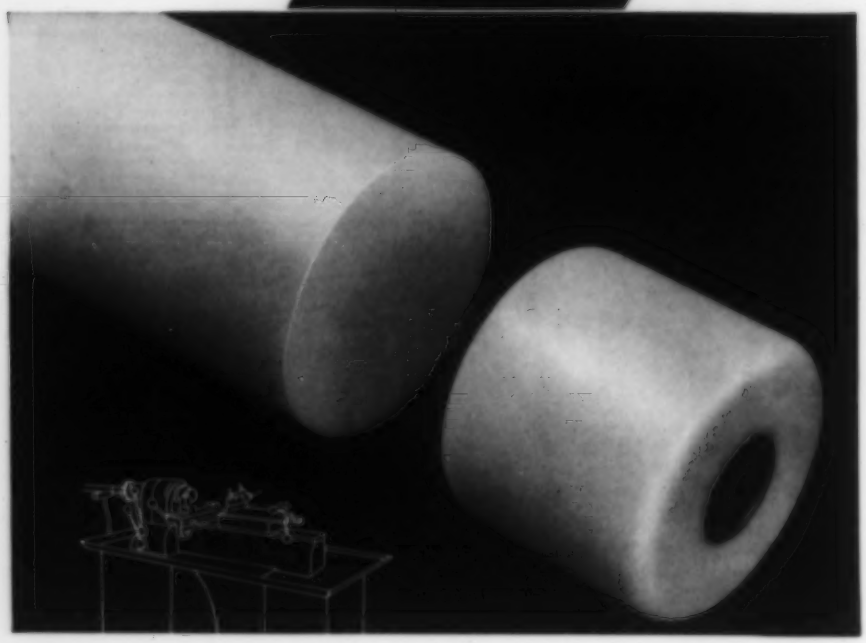

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- No costly delays in your production schedules . . . POLYPENCO Nylon Shapes are carried in stock, available for immediate delivery in stock sizes.

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*DU PONT TRADEMARK

New Parts

and tachometer generator on a single shaft eliminates backlash. Unit is available with five different gear reduction ratios, 191.1:1, 76.6:1, 32.4:1, 13.8:1 and 5.8:1, and with motor ratings of either 1, 5 or 10 w output. The same tachometer - generator component is used with each of the three motors. It has an input of 115 v, 60 cycles, output of 5.5 v per 1000 rpm and linearity of 1 per cent. Unit can be adjusted after installation. Made by **Diehl Mfg. Co.**, Finderne Plant, Somerville, N. J.

For more data circle MD-99, Page 215

Pneumatic Valve

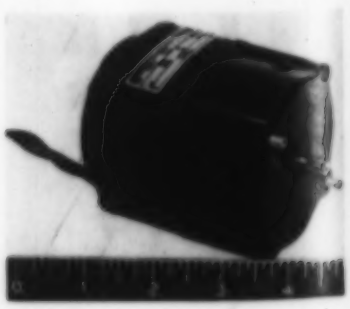
Shear-Seal four-way air valve, model 2801, operates at pressures to 250 psi. Any port can be used as the pressure port, and the valve

body can be rotated in 90-deg intervals for most convenient piping. A mounting bracket furnished with the valve can be turned to any desired position. Valves are available in ¼ and ⅜-in. port sizes. Made by **Barksdale Valves**, 5125 Alcoa Ave., Los Angeles 58, Calif.

For more data circle MD-100, Page 215

Synchronous Gearmotor

Output speeds of 1800 and 300 rpm are provided by this two-speed, synchronous gearmotor. Speed reduction below the normal 1800 rpm is accomplished by electrically reversing the motor and picking up a gear train through an internal overriding clutch. The



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THE MOTOR THAT COULDN'T BE BUILT BEFORE

Now, in a complete line of totally enclosed motors, Baltric brings you the best answer yet to your motor problems. Less weight . . . less bulk . . . better performance, are the results of advanced engineering and new and better materials.

The new Baltric Motors pack much more power per ounce . . . permit applications and installations of greater versatility. Simple in design, rugged, yet compact and dependable, Baltric does a better job in less space than old-style motors. Baltric is a better bet for every use.

Baltric Motors are available in a complete range of models, ⅛ h. p., through 5 h. p., squirrel cage induction type, both polyphase and single phase. Baltric Motors can also be engineered to meet your special mechanical and electrical requirements.

Original *Streamcooled* Baldor Motors Available—Built to Former NEMA Standards

ALL BALTRIC MOTORS TOTALLY ENCLOSED AND *STREAMCOOLED*

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ALDOR ELECTRIC COMPANY

Baltric Motors Are Available in Polyphase Squirrel Cage · Induction and Single Phase Capacitor Start · Induction Run Types

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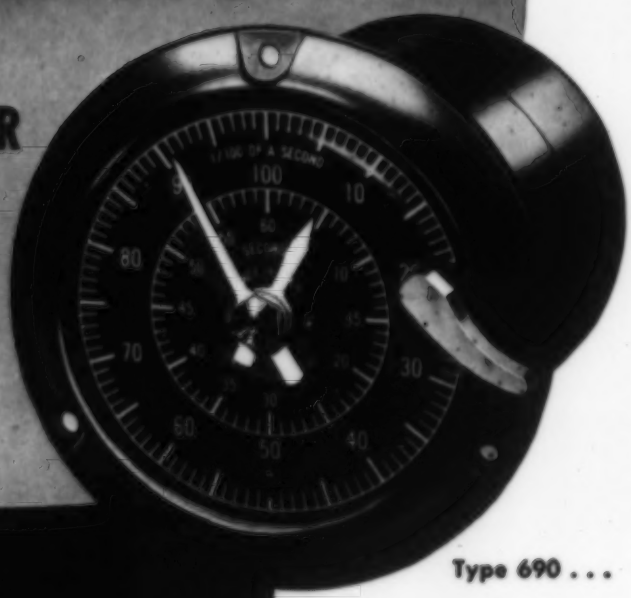
Cramer

TIME TOTALIZER

a highly accurate electrical stop clock . . .



Type 690 . . .

DIFFERENTIAL SYSTEM ASSURES FAST, POSITIVE CLUTCH ACTION — PREVENTS SLIPPAGE OR OVERRUN

Positive engagement of pawl with gear combined with fine gear teeth provides the instant response necessary for a timing accuracy of ± .01 seconds on the 60-second timer, and ± .005 minutes on the 60-minute unit.

On the dial face, a large sweep hand makes possible fast, exact readings from the outer scale, while an accumulator pointer records larger time units on a separate scale in the center of the dial.

This compact unit is available for AC or DC operation in commercial and military applications. It is used in laboratory experimentation, for testing communications equipment and systems, and in the field of nuclear research, as well as for timing critical industrial processes.

For complete information on the Type 690, write for bulletin PB-610.

Cramer TIMING DEVICES

SPECIALISTS IN TIME CONTROL

The R. W. CRAMER CO., Inc.

BOX 6, CENTERBROOK, CONNECTICUT

11CR55

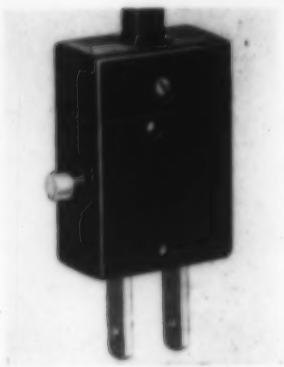
New Parts

output shaft rotates in the same direction at either speed. Basic motor is of the permanent split-capacitor type, designed for operation on 115-v, 60-cycle current, and draws 10 w at rated load. Motor is available with other speeds and output shaft variations. Made by **National Pneumatic Co. Inc.**, Holtzer-Cabot Motor Div., 125 Amory St., Boston 19, Mass.

For more data circle MD-101, Page 215

Circuit Breaker

Type MP-452 Mini-Breaker fits on the cord end of appliances, instruments and other electrical equipment employing 3 to 10-amp circuits to provide protection against overloads and short circuits. Service can be restored



within 10 seconds after interruption by pressing the reset button. Breaker is trip-free, and it will not maintain a circuit that has not been cleared. Made by **Mechanical Products Inc.**, 1840 River St., Jackson, Mich.

For more data circle MD-102, Page 215

Variable-Volume Pump

A variable-volume vane type pump for hydraulic service, the Multipump delivers variable volume at constant speed, or constant volume at variable speed. Easily adjusted volume control works independently of compensator. A compensator control works at all volumes. A stop for minimum volume is available. The pump holds volume within ±5 per cent over desired pressure and designed speed ranges. Preset volume and

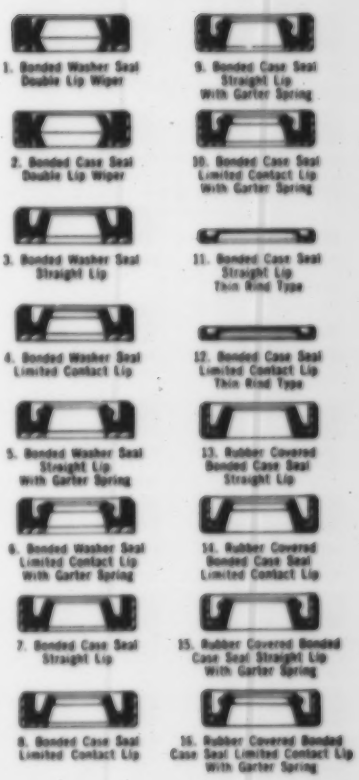
PULL IT . . . TWIST IT . . . STRETCH IT

Bonded IPC Packings Stay Bonded

Here's proof that "Bonded by IPC" means absolute adhesion . . . rubber to metal. Exerting more stress would only result in bending the metal case, or in tearing the synthetic rubber, but the IPC bond between will not break down.

Case seals and bonded washer seals will probably never face such grueling strain in actual use . . . but the fact remains . . . they could.

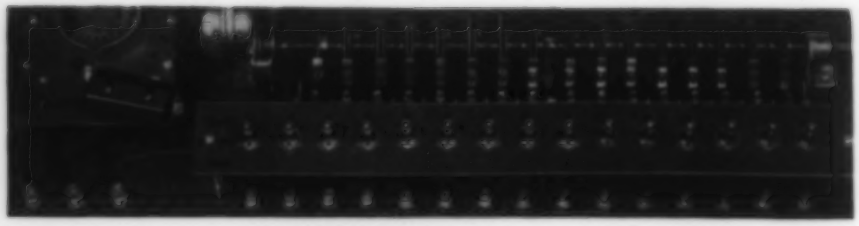
Whatever your sealing problem, you can rely on IPC packings. They will be custom designed and IPC experience assures low cost dependability.


1. Bonded Washer Seal Double Lip Wiper
2. Bonded Case Seal Double Lip Wiper
3. Bonded Washer Seal Straight Lip
4. Bonded Washer Seal Limited Contact Lip
5. Bonded Washer Seal Straight Lip With Garter Spring
6. Bonded Washer Seal Limited Contact Lip With Garter Spring
7. Bonded Case Seal Straight Lip
8. Bonded Case Seal Limited Contact Lip
9. Bonded Case Seal Straight Lip With Garter Spring
10. Bonded Case Seal Limited Contact Lip With Garter Spring
11. Bonded Case Seal Straight Lip Thin Rind Type
12. Bonded Case Seal Limited Contact Lip Thin Rind Type
13. Rubber Covered Bonded Case Seal Straight Lip
14. Rubber Covered Bonded Case Seal Limited Contact Lip
15. Rubber Covered Bonded Case Seal Straight Lip With Garter Spring
16. Rubber Covered Bonded Case Seal Limited Contact Lip With Garter Spring

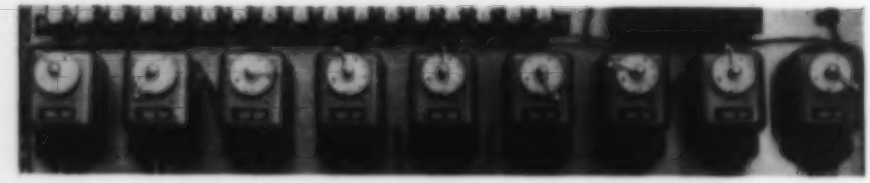
INTERNATIONAL PACKINGS CORPORATION

Bristol, New Hampshire

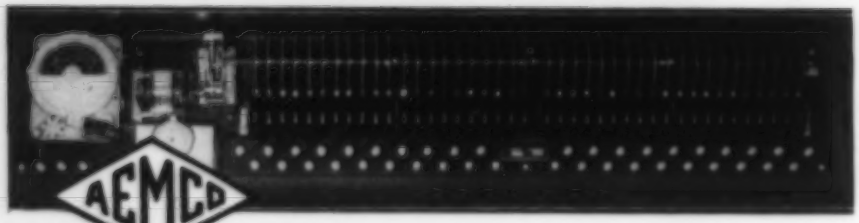
P4



switching . . .



to automatic control?



has a complete line of relays, timers and time switches to assist you

Specialists in the control field for more than 30 years, AEMCO engineering offers you fresh, new ideas . . . ideas that save you money in automatic control . . . ideas that save you valuable time. Yes, AEMCO is selling service as well as a complete line of relays and both automatic re-set and sequence timers.

AEMCO

RELAYS

At AEMCO we specialize in both the design and manufacture of relays to your mechanical and electrical specifications. Should one of hundreds of stock AEMCO relays fail to meet your specialized requirements exactly, we will design and build a unit not only to meet, but to exceed those specifications.

- Open or can types
- Miniatures and sub-miniatures
- Power Relays
- Delayed make or break types
- Circuit control relays
- Current and potential relays

For detailed information on the complete AEMCO relay line, write for your copy of Ready Catalog H.

AUTOMATIC RE-SET AND SEQUENCE TIMERS

Now control that vital operation . . . automatically! Available in many different models with automatic or manual reset, AEMCO industrial time controls help eliminate waste . . . help speed up production. Variations are available on standard cycling models . . . dials are easy to read, easy to set.

- AR and MAR—Automatically re-cycles at end of cycle
- ARD and MARD—Re-cycles with an interruption of current
- ARR—Repeating cycle
- MARA—Two circuits—both closed and open. Circuits completely adjustable
- No. 400—Sequence timer. Momentary start—automatic stop or continuous cycling. Any number of circuits.

For detailed information on AEMCO industrial time controls, write for your copy of AEMCO's Time Control Bulletin.

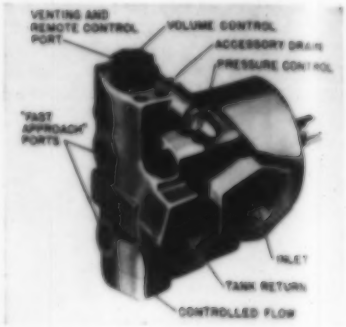
AEMCO

AUTOMATIC ELECTRIC MANUFACTURING CO.

64 STATE STREET • MANKATO, MINNESOTA

TIME SWITCHES • INTERVAL TIMERS • SIGN FLASHERS • RELAYS

New Parts

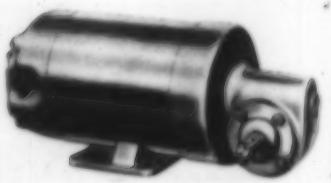


preset pressure are delivered to the system. Pump delivers only the oil needed by the hydraulic circuit; excess volume is delivered to the tank at low pressure. It is available in three basic sizes with capacities of 5, 15 and 25 gpm at 1200 rpm. All three sizes are designed for 1000 psi continuous duty. Made by **Denison Engineering Co.**, 1160 Dublin Rd., Columbus 16, O.

For more data circle MD-103, Page 215

Gearmotors

Eight standard ratios ranging from 5:1 to 60:1 are offered in line of small gearmotors which utilize

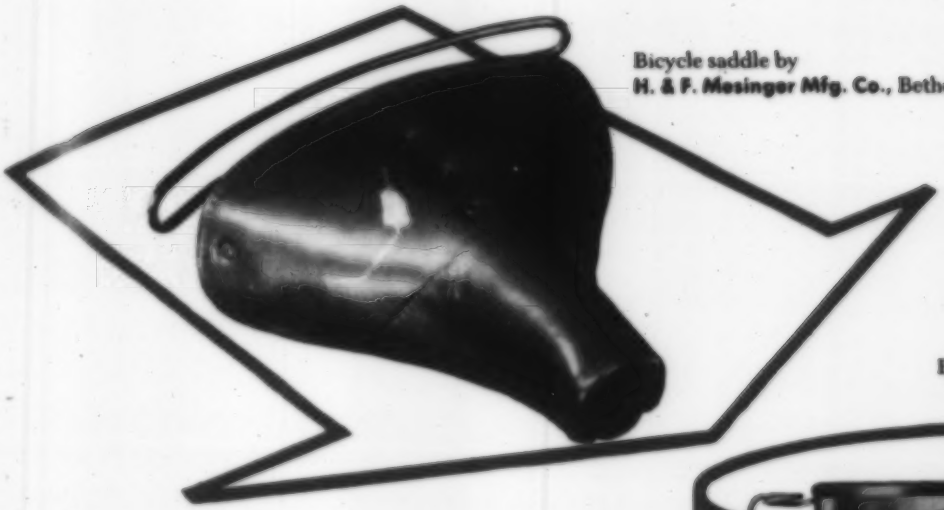


NEMA 42 frame motors in 1/20 and 1/12-hp ratings. Motors can be split-phase; capacitor-start, induction-run; capacitor-start, capacitor-run; or polyphase. Open and totally enclosed constructions with prelubricated ball bearings are offered. Gear box can be mounted in several positions. Made by **Doerr Electric Corp.**, Cedarburg, Wis.

For more data circle MD-104, Page 215

Plastisol Adhesive

Made specifically for the adhesion of plastisol materials to metal surfaces, new 12-837 adhesive is highly resistant to chemicals. It also prevents sub-surface film corrosion. The adhesive must be cured



Bicycle saddle by
H. & F. Mesinger Mfg. Co., Bethel, Conn.

Blackstone Automatic Washer made by
Blackstone Corp., Jamestown, N. Y.

"Nomar" anchor by
Whitman & Robinson,
Weedsport, N. Y.

Plastisols used in these products
were formulated by
Stanley Chemical Co., East Berlin, Conn.

Products on the *MOVE*--with Plastisols

Here's an anchor that won't mar boat decks, because it's coated with soft, resilient plastisol . . .

A tough, weatherproof bicycle saddle with a red leather grain, rivet heads—even the stitching—all one piece, molded from plastisol . . .

And a washing machine collector tank coated and sealed on the inside—the work side—with durable plastisol.

Does some product of yours have to operate under conditions like these? Sea water, sun, scalding water, soap, corrosion, chemicals, abrasion, flexing . . . plastisols based on BAKELITE Brand Vinyl Dispersion Resins take them all in stride.

Easy-flowing plastisols are simple to work with, either for coating or molding. Use them for dip-coating, slush molding, injection molding. They form with little or no pressure, without harm to an assembly's delicate components. A short bake fuses them into a firm, resilient material. They have good electrical insulating properties. They can be given almost any color you wish. Their finishes can be glossy or soft.

All these features result in a surprisingly low cost in terms of service and production advantages. For information and technical assistance in applying plastisols based on BAKELITE Vinyl Dispersion Resins, write Dept. HN-103.

BAKELITE
BRAND
Vinyl Dispersion Resins

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC

Titan

brass pressure die castings

- cut fabrication costs
- simplify secondary machining
- are made in complex shapes
- have consistent uniformity
- allow large weight savings
- increase production rates

A pioneer in manufacture of brass pressure die castings, Titan can supply these parts to meet your requirements. Little or no secondary machining operation is needed on Titan pressure die castings. Intricate shapes and deep cored holes are readily produced, are consistently uniform. To save weight, wall sections as thin as .070 inches are generally feasible; but 1/32 inch section is possible if not too large in area. Machine scrap is reduced, and your fabrication costs cut. Moreover, the better surface finish, sharper outlines, greater accuracy, higher strength, and finer grain structure of Titan brass pressure die castings make them unquestionably superior to sand and other types of castings.

Anyone of these versatile advantages may be reason enough to specify Titan brass pressure die castings as components in your finished product. Find out what Titan can do for you.

Send for 12-page booklet on Titan brass pressure die castings

Titan®

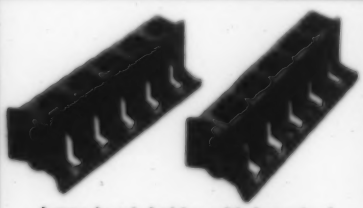
METAL MANUFACTURING CO.
BELLEFONTE, PA.
Offices and Agencies in Principal Cities
RODS • FORGINGS • DIE CASTINGS
WELDING RODS • WIRE

VISUAL PROOF

These photos demonstrate how little secondary machining is required on typical Titan pressure die castings. In each case a part as cast and trimmed only, and the same part machined are shown.

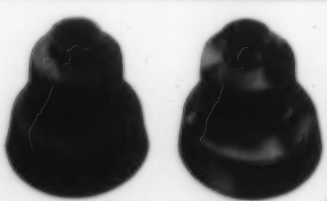
Flywheel for garbage disposal unit

Small brush holder



Large brush holder with broached holes held to close tolerance

Overflow plate and trip handle



Shower head

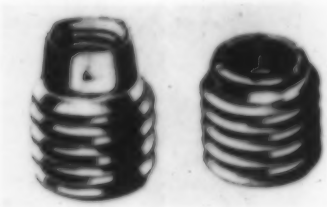
New Parts

or baked at 380 to 400 F for 10 minutes to obtain ultimate adhesion. When properly applied to surfaces which are free from oil, grease and dirt, it will provide adhesion of 18 to 24 lb per linear inch. Made by **Watson-Standard Co.**, 216 Galveston Ave., Pittsburgh 12, Pa.

For more data circle MD-105, Page 215

Self-Locking Bushings

These self-locking, vibration-proof bushings can be used in relatively soft castings, forgings and extrusions such as aluminum alloy, magnesium, mild steel and some plastics. Type N2424, with a red nylon locking collar, is made for use at temperatures up to 250 F; all-metal type LH2424 is for use at



temperatures between 250 and 550 F. External threads of the bushing lock in the parent material, resulting in a positive locking action that resists the loosening effect of vibration or the backing-out torque of the bolt. Bushing develops minimum ultimate loads of 140,000 psi based on internal thread size in soft alloy castings of materials such as aluminum and magnesium. Bushings are now available in 10-32, $\frac{1}{4}$-28, $\frac{5}{16}$-24 and $\frac{3}{8}$-24 internal thread sizes. Made by **Elastic Stop Nut Corp. of America**, 2330 Vauxhall Rd., Union, N.J.

For more data circle MD-106, Page 215

Hollow Shaft Differential

Precision model T700 hollow shaft differential rotates at high speeds with minimum backlash and low breakaway torque. Simple shaft lock permits easy removal of differential from gear train without disassembling the end plates. Differentials are available for

(*Continued on Page 266*)

At an Eastern food processing plant, slices of No. 1 potatoes up to 1¼-inch are pumped at 80 RPM, smaller diced No. 2 potatoes at 150 RPM. Mixers feed the salad into hoppers leading into the pump. A B-10 Moyno food pump moves the large slices gently through the pump and a 4-inch glass pipe into standard filling machines that fill pint, quart, and gallon jars. When the Moyno isn't pumping potato salad, it pumps other foods such as cooked cranberries, whole-kernel corn, pickle relish.

This Moyno® Pumps Potato Salad With Slices Up To 1¼-inch...Without Crushing!

The Moyno can pump potato salad and a lot of other materials without making mush out of them—because of the unique *progressing cavity* principle.

Moynos have no valves and pistons, no vanes or other devices that cause churning and turbulence. The Moyno has a simple screw-like rotor turning within a double-threaded stator. This design creates cavities which progress smoothly toward the discharge end of the pump, carrying the material being handled. The material is not squeezed or churned.

Pumps Practically Anything

That's why the Moyno successfully handles such hard-to-pump materials as non-pourable pastes, frits, plaster, highly volatile liquids, and materials containing large particles, such as potato salad, fruit, cherries, chow mein—even oysters! In fact, the Moyno handles practically anything that will pass through a pipe.

Many Other Advantages

Moynos pump many hard-to-pump materials with a minimum of abrasion and wear. Many plants have adopted Moynos simply because they last so long.

Moynos provide positive displacement. Moynos can pull up to 29 inches vacuum while discharging under pressure. Big Moynos deliver up to 500 gpm; can provide pressures up to 600 psi in the smaller frame sizes. They even get up to 1000 psi momentarily.

The Moyno is reversible—it pumps equally efficiently in either direction.

With the Moyno, accurately metered flows are obtainable by regulating operating speed.

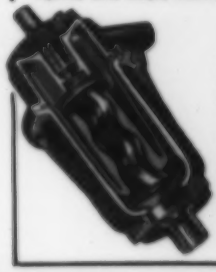
Moynos are trouble-free. They are self priming; won't cavitate or vapor-lock. There's just one moving part—no valves to stick, no pistons to gum up. Built for tough service. Easy to maintain. Moyno pumps are easy to take apart for cleaning.

Write For Bulletin

You may save a good deal of money or solve a tough problem by finding out about this simple, versatile pump. Write for Bulletin 30MD.

HOW IT WORKS

Rotor is like a stretched-out corkscrew. It turns within a stator that has a double internal thread. Thus rotor and stator form closely fitted cavities. As the rotor turns, these cavities progress evenly toward the discharge end of the pump without closing up. That's why the Moyno easily handles materials without crushing, churning, or aerating; and why it can handle so many different things—solids in suspension, pastes, abrasives, highly volatile liquids, tars, soaps, caustics—even cement and plaster.



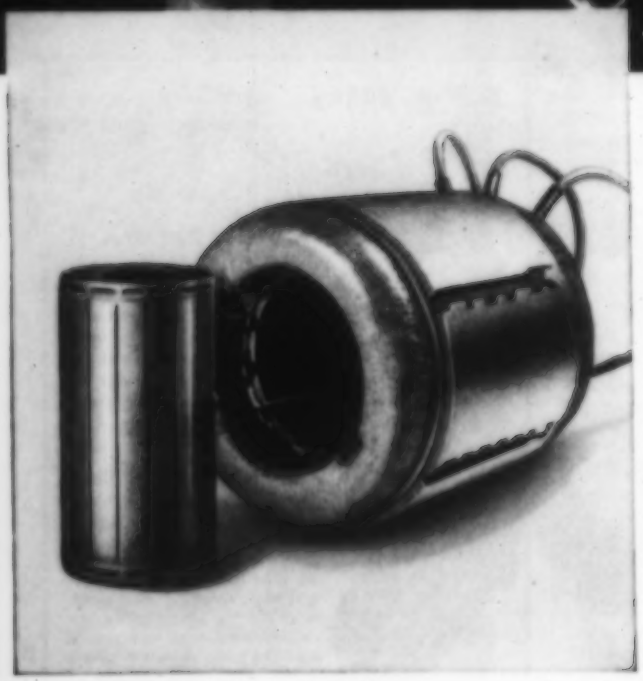
FOR DESIGN ENGINEERS

Moynos are available in small sizes and special designs for use in automatic washers, drink dispensers, sprayers, oil burners, machine tools, gasoline pumps, and a wide variety of other equipment. If you are designing machinery, we'll work with you, in confidence, to integrate pump design with your problem.

ROBBINS & MYERS, INC.

SPRINGFIELD, OHIO • BRANTFORD, ONTARIO

Fractional and Integral HP Motors · Desk, Window, and Household Fans · Hoists and Cranes · Moyno Pumps · Propellair Industrial Ventilating Equipment



R&M MOTOR PARTS AT WORK

A prominent passenger car manufacturer gets eleven times more chassis per gallon—reducing paint and production costs substantially—with the efficient, high-quality electrostatic paint spray process of the Ransburg Electro-Coating Corp., Indianapolis, Ind. Robbins & Myers polyphase motor parts are utilized to atomize the paint spray in an electrostatic field. The spray is attracted to the products, which are grounded through the hanger, producing a high degree of uniformity of finish.

◀ Rugged rotor and stator for a polyphase portable tool. The rotor consists of squirrel cage, embedded in laminated core with bars and end rings of copper, brazed or welded together. The stator has a high-grade silicon steel core with top-quality rag paper used to insulate the coil from the core. The finished winding is taped and thoroughly impregnated with high-grade synthetic resin base varnish to assure trouble-free operation with minimum danger of short circuits and grounds.

ROBBINS & MYERS, INC.

MOTOR DIVISION: SPRINGFIELD 99, OHIO • BRANTFORD, ONTARIO

Fractional & Integral h.p. Motors & Generators

Household Fans

Electric & Hand Hoists & Cranes

Moyno Pumps

Propellair Industrial Ventilating Equipment

R & M SPECIALISTS INTEGRATE MOTOR AND MACHINE DESIGNS... TO ASSURE HIGHEST PERFORMANCE

Many factors must be considered in designing a new motor-operated product that will perform its intended functions accurately, economically, and with a low maintenance and failure rate. Much depends on the proper correlation and integration of motor and machine designs. A special knowledge of motor application can be valuable to you. Robbins & Myers motor design specialists can help you solve these problems, to whatever extent you desire.

The exact motor for your machine is worked out quickly and accurately, with systematic methods of designing motors. This might include, for example, the use of R & M's unique "Electrical Slide Rule." Electrical equivalents can be set up on the slide rule to simulate the conditions under which the motor must operate in your product. By this method we are able to investigate hundreds of different design possibilities, assuring the best motor for the job.

In some cases the answers point to a standard motor. And here, R & M offers a wide variety of types and sizes of complete motors or matched motor parts.

In other cases special motors are indicated. R & M is equipped to do a fast, thorough, economical job of custom-designing a motor that's exactly right for your product.

Don't settle for an "off-the-shelf" compromise. Standard or custom-designed, R & M will get you the right answer quickly —with no obligation!

R & M MOTORS AND MOTOR PARTS POWER MANY TYPES OF EQUIPMENT, SUCH AS . . .

Portable Saws	Routers	Nut Setters	Hedge Trimmers
Drills	Screw Drivers	Hammers	Lawn Mowers
Nibblers	Pumps	Polishers	Oil Burners
Lock Mortisers	Compressors	Planers	Surgical Instruments
Valve Grinders	Hones	Portable Grinders	Grease Guns
Vacuum Cleaners	Business Machines	Sirens	Vibrators
Fans	Cast Cutters	Advertising Devices	Die Sinkers
Sanders	Food Mixers	Ventilating Equipment	Waxers

R&M MAKES BOTH!
Fractional-horsepower motors and parts . . . from 1/200 h.p.

If it's an R&M, it's the Right Motor!

Integral-horsepower motors; famous R&M "All-Weather"* with sealed bearings. Up to 200 h.p.

**"All-Weather" is an R & M trademark*

This coupon will bring you prompt information. MD

Robbins & Myers, Inc., Motor Division, Springfield 99, Ohio

Please send me, without obligation, information on:

- ☐ Motor Parts for Portable Tools
- ☐ Universal Motors
- ☐ Capacitor Motors
- ☐ R & M "All-Weather" Motors —up to 200 h.p.
- ☐ Please have a Motor Specialist call

Product we manufacture: _____

Name _____

Title _____

Company _____

Street _____

City & State _____

3 REASONS WHY DESIGN ENGINEERS PREFER THESE THREE JOHN CRANE "PRESSED-IN" SEALS

- √ Quickly Installed
- √ Extremely Compact
- √ Low in Cost

STATIONARY SEALING HEAD TYPE 11-A

A. Seal Retainer.
B. Synthethic Rubber Bellows.
C. Metal Band.
D. Spring.
E. Holding Dents.
F. Precision-Lapped Sealing Washer.

This pressed-in packaged sealing unit is designed with the spiral steel spring inside of the synthetic rubber bellows to protect it against corrosion.

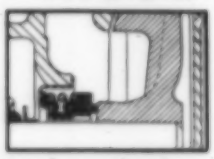
The spring clamps the flange of the bellows tight against the bottom of retainer and the metal ferrule squeezes the top portion of the bellows against the "Teeplelite" washer.

This liquid-tight seal is especially recommended for small shafts on *hot or cold water, oil, gasoline, kerosene, soapy water.*

Use this seal on: *Low Pressures* to 35 PSI
Temperatures −65°F. to +220°F.

STATIONARY SEALING HEAD TYPE 6-A

A. Seal Retainer.
B. Metal Ferrules.
C. Spring.
D. Precision-Lapped Sealing Washer.
E. Holding Dents.
F. Synthetic Rubber Bellows.

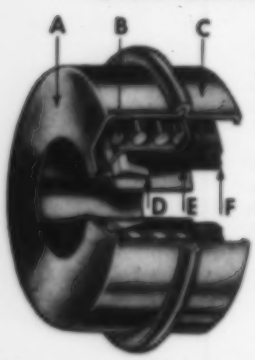


This pressed-in packaged sealing unit is designed with a spiral steel cadmium plated spring (stainless or bronze optional) assembled between two metal ferrules which clamp the flanges of the synthetic rubber bellows tightly against the retainer shell and the "Teeplelite" washer.

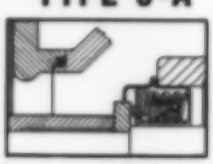
This liquid-tight seal is especially recommended for small shafts on *hot or cold water, oil, gasoline, kerosene, soapy water.*

Use this seal on: *Medium Pressures* to 75 PSI
Temperatures −65°F. to +220°F.

STATIONARY SEALING HEAD TYPE 9-A



A. Seal Retainer.
B. Spring.
C. Sleeve.
D. Wedge of Teflon.
E. Sealing Washer.
F. Precison-Lapped Face.



This pressed-in packaged sealing unit is designed to use a wedge sealing ring of Teflon*. This wedge shaped sealing ring closely fits the inner sleeve of the retainer and makes a liquid-tight contact with cone surface of carbon washer.

The result is a liquid-tight seal which is especially recommended for *hot oil, and all chemical liquids or gases, hot or cold.*

Use this seal on: *High Pressures* to 150 PSI
High Temperatures +485°F. *Low Temperatures* −120°F.

Write for fact-filled catalog. Crane Packing Company, 1825 Cuyler Ave., Chicago 13, Ill.

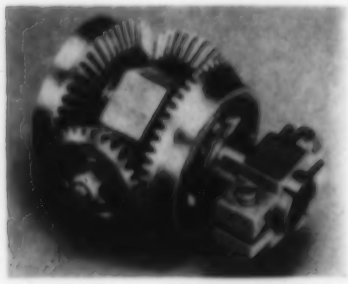
In Canada: Crane Packing Company, Ltd., 617 Parkdale Ave., N., Hamilton, Ont.

*DuPont trademark

JOHN CRANE CRANE PACKING COMPANY

New Parts

(*Continued from Page 262*)

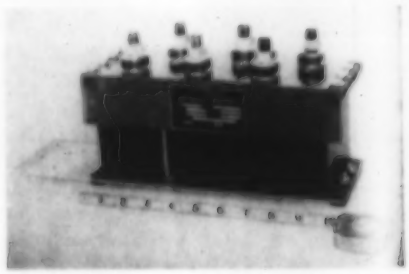


0.062, 0.125, 0.187 and 0.250-in. diameter shafts. They are constructed of stainless steel and have precision ball bearings. Made by **Sterling Precision Instrument Corp.**, Instrument Div., 34-17 Lawrence St., Flushing 54, N. Y.

For more data circle MD-197, Page 215

Germanium Rectifiers

Diffused junction germanium power rectifiers convert alternating to direct current and operate with high power output and efficiency and without aging. Small in size, they can be supplied for voltage ranges from 10 v to 100 kv and from 10 to 100,000 amp by



connecting junctions and assemblies in series or parallel. Photo shows fan-cooled unit, rated at 750 amp at 40 v in a three-phase half-wave circuit. Voltage drop is 0.75-v per junction. Unlimited operating life is obtained over a temperature range of −55 to 75° C. Natural and forced convection and liquid cooled types are offered. Made by **International Rectifier Corp.**, 1521 E. Grand Ave., El Segundo, Calif.

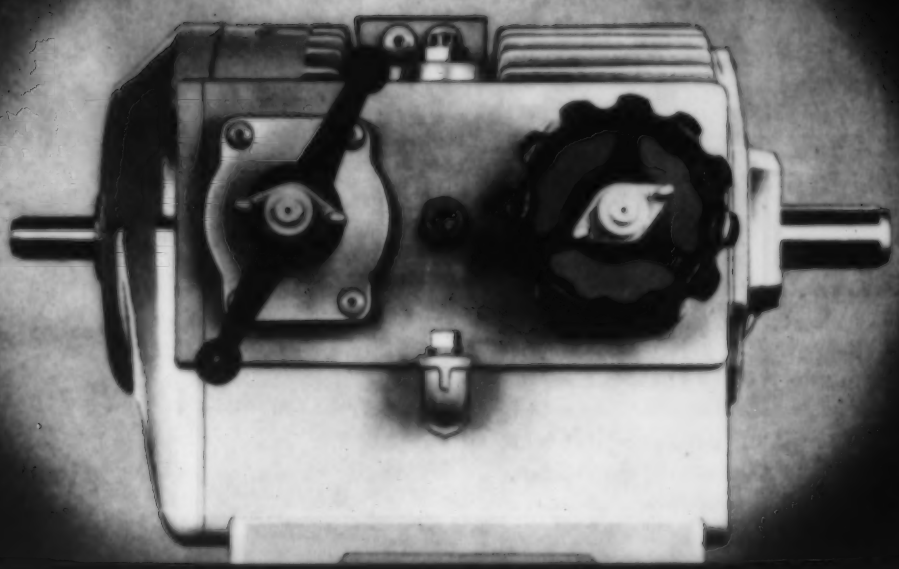
For more data circle MD-198, Page 215

Fractional-Horsepower Motors

Intended for use on appliances, auto window lifts, seat adjustors, windshield wipers, air conditioners,

Presenting...the NEW GEROTOR

Variable Speed Hydraulic Transmission



Many applications require a smooth power source that will provide instantly variable speeds, without stopping; automatic braking; positive speed change response and reverse rotation. The versatile *new* GEROTOR VARIABLE SPEED HYDRAULIC TRANSMISSION meets all of these requirements . . . and many more. This new transmission is a compact, self-contained power package that does away with space-consuming cones, pulleys, chains and belts.

Send for descriptive literature TODAY. Learn how GEROTOR can solve your variable speed problems.

The Gerotor Transmission combines all of these modern design features--

- Infinitely Variable Speeds — 0 to 1500 rpm without gearing
- Constant or Variable Torque and Horsepower
- Smooth Braking — instantaneous or delayed
- Full Range of Controls — from hand to automatic remote
- Rugged, Compact, Symmetrical Design
- Highest Torque in Low Speed Range
- Positive Overload Protection
- Saves Maintenance Costs
- Rapid Reversing

MANUFACTURERS OF

GEROTOR

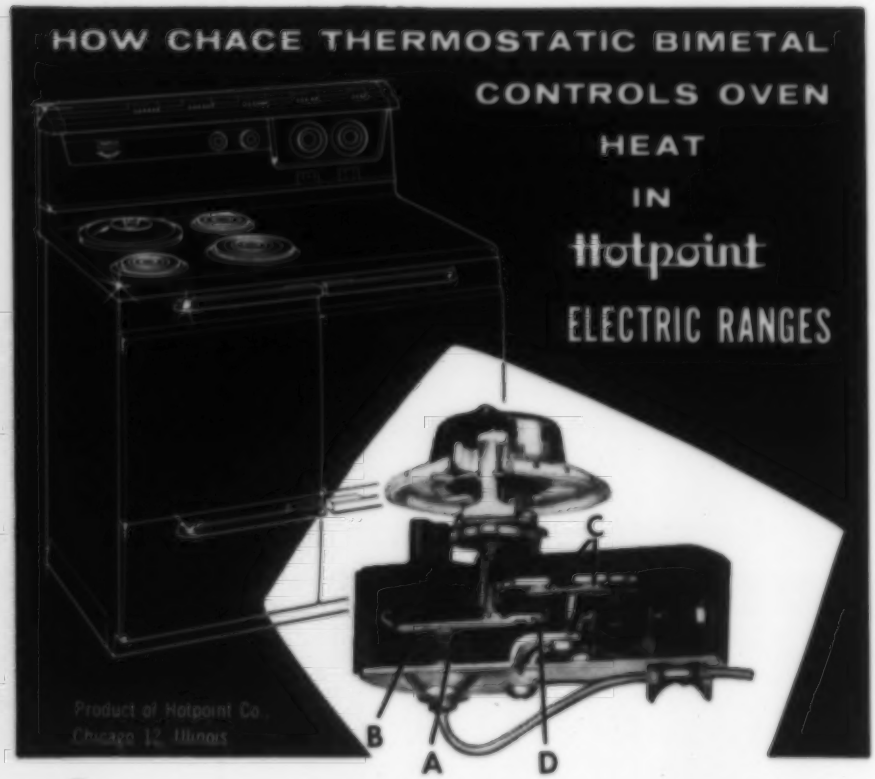
MAY CORPORATION

1537 MARYLAND AVENUE • BALTIMORE 3, MARYLAND

Hydraulic Pumps and Motors

Variable Speed Hydraulic Transmissions

PneuBin —pneumatic bin evacuators



During the last fifty years, the Hotpoint Company has pioneered in the development of the electric range to its present highly refined state. Naturally, dependable regulation of oven temperatures is essential to efficient operation. Therefore, the Hotpoint range depends upon Chace Thermostatic Bimetal as an integral part of the temperature controlling thermostat.

The Hotpoint thermostat functions to control oven heat by two means: an oven-mounted sensing bulb reacts to a preset temperature by the expansion of contained fluids which impart a force on the expansible and contractible bellows assembly (A), and on the operating blade (B), to break the circuit of the double pole contacts (C), with a snap-action.

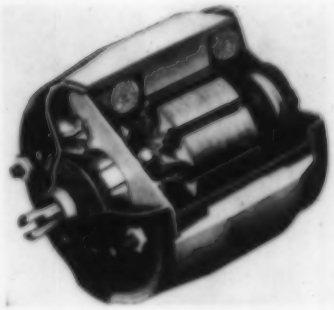
Since much of the fluid contained within the bellows assembly is *exterior* to the oven and subject to the expansion and contraction effects of extraneous temperatures, Chace Thermostatic Bimetal (D) is employed in a section of the operating blade to function as an automatic compensator for eliminating the effects of undesired temperature sensing. Its flexing adds to or subtracts from the forces of curvature of the operating blade depending upon whether the temperature is below or above the design base—average room temperature.

Prolonged oven operation will cause a temperature build-up in the range backsplasher (as high as 200° F.) so that the range, if not provided with a compensating Chace Thermostatic Bimetal element, would supply temperatures some 120° F. lower than desired.

Write now for our free booklet containing design and application data for the 29 different types of Chace Thermostatic Bimetal.

W. M. CHACE CO.
Thermostatic Bimetal
1616 BEARD AVE., DETROIT 9, MICH.

New Parts

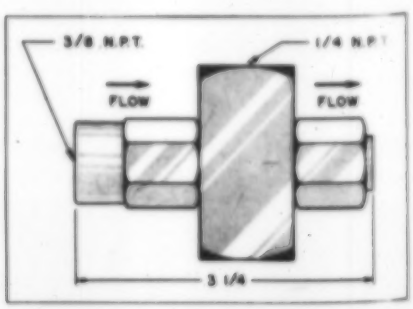


marine pumps and blowers, type TW MicroMotor is wound for dc and ac operation. It is available in sizes from 1/100-hp at 1500 rpm to ¼-hp at 15,000 rpm. Feature is the skewing of the field laminations where straight slots are used in the armature to facilitate armature winding operations. In the Uni-cast field, laminations are stacked and die cast together under pressure to prevent shifting and vibration during motor operation. Made by **Redmond Co.**, Owosso, Mich.

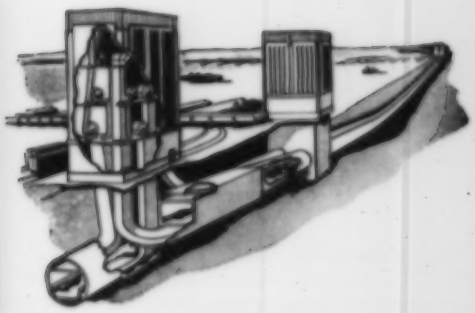
For more data circle MD-109, Page 215

Vent and Breather Valve

This pop-off relief valve seals tight without leakage below release pressure and reseats absolutely tight within 10 per cent of this value. Sealing is provided by a resilient member fitted into the poppet head which seats into a spherical section in the valve body. In the closed position, the metal-to-metal seating limits the compressive load on the resilient seal and contains it to withstand the pressure load. Adjustment is internal. Valve can be used at pressures to 125 psi where maximum flow and minimum pressure drop are required. A dual relief valve unit is also available, designed to meet ASTM requirements and capable of controlling temperature-induced



Morse equipment helps ventilate Lincoln Tunnel for 18 years — without replacements!



Lincoln Tunnel: Operated by The Port of New York Authority, it is a major artery connecting mid-Manhattan with New Jersey.

Here, 26 blowers and 30 exhaust fans circulate millions of cubic feet of air per minute through the tunnel. Because these ventilation units provide a complete change of air in the tunnel every 1½ minutes, they require dependable power transmission equipment. It is significant that Morse power transmission equipment is used in many of these units.

Shown at left is a typical blower unit, which employs a 6 in. Morse Silent Chain operating at 7½ hp at 445 rpm or 60 hp and 884 rpm. This unit, as well as the others in the ventilation system, has been operating for 18 years with little maintenance, and no breakdowns.

Check These Advantages of Morse Equipment:

- Long service life
- Low operating cost
- Easy to assemble, disassemble
- Require minimum maintenance
- Wide range of types and sizes
- Precision construction

Morse Power Transmission equipment gives reliable, economical performance in unusual applications.

Look into the complete line of Morse Power Transmission products which you can employ in your own design applications. Morse has skilled engineers available to help you solve practically any problem involving transmission equipment: Roller Chain, Silent Chain, Sprockets, Clutches, and Couplings.

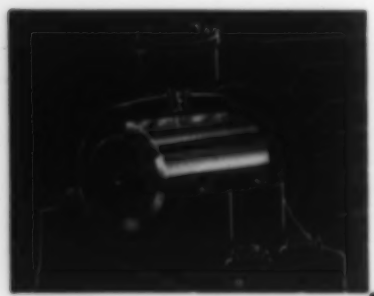
MORSE CHAIN COMPANY,
INDUSTRIAL SALES DIVISION,
ITHACA, NEW YORK

MORSE BW **CHAINS, CLUTCHES, AND COUPLINGS**

Nothing else needed

...WHEN YOU SPECIFY BUNTING BEARINGS

The Cast Bronze Bunting Bearing is delivered ready for installation—with the easy assembly in housing and on shaft all that is necessary. No lock nuts, lock washers, end covers are required to increase initial cost and assembly cost. Bunting engineers will gladly aid you in making specifications for the Bunting Bronze Bearing that exactly meets your need. There is a Bunting engineer near you for consultation, or write our Product Engineering Department at Toledo.



Where the Bunting Bearing is the floating type it is inserted by hand. Where the pressed—in type is employed, the bearing is simply pressed into the gear, gear box, lever or housing.

Bunting

BRONZE BEARINGS • BUSHINGS • PRECISION BRONZE BARS

THE BUNTING BRASS AND BRONZE COMPANY, TOLEDO 1, OHIO

BRANCHES IN PRINCIPAL CITIES • DISTRIBUTORS EVERYWHERE

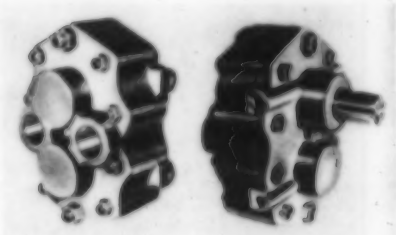
New Parts

positive or negative pressure changes in power transformers. It can be installed either outside or inside the transformer case. Made by **James-Pond-Clark,** 2181 E. Foothill Blvd., Pasadena 8, Calif.

For more data circle MD-110, Page 215

Hydraulic Pumps and Motors

Five hydraulic motor models deliver from 7 to 27 hp at 800 rpm with a pump pressure of 1000 psi. Series of five hydraulic pumps of comparable capacity operate at

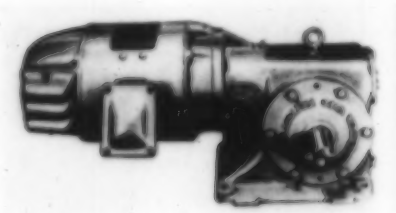


pressures up to 1200 psi at 1500 rpm. All units are made with precision cut steel gears, ground and polished shafts, needle bearings and an oil seal which eliminates need for outside bleed. Four extended tapped bosses simplify mounting. Made by **Hydra-Flex Inc.,** Claremont, Minn.

For more data circle MD-111, Page 215

Motorized Worm Gear Reducer

Self-contained, compact right-angle worm GearMotor is available in sizes from 1 to 50 hp, with reduction ratios from 3⅝:1 to 90:1. Gearing and bearings are oversized



to provide high strength. A flexible coupling connecting the motor shaft and worm shaft is enclosed within the gear unit. Made by **Philadelphia Gear Works Inc.,** Erie Ave. and G St., Philadelphia 34, Pa.

For more data circle MD-112, Page 215

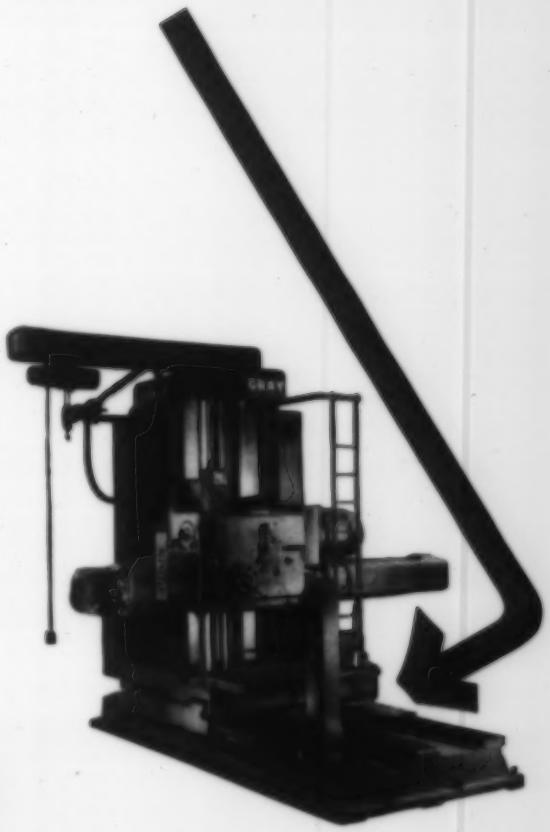
the G. A. GRAY CO. says OK hardened ways insure absolute accuracy during the long life of new 650 FC horizontal boring machine

THE G. A. GRAY CO., one of the world's most respected large machine tool builders, uses hardened and ground bedways and cross ways made by the Ohio Knife Co. In addition to insuring absolute accuracy during the long life of this machine, OK Hardened Bedways are the perfect mating surface for GRAY non-metallic bearing surfaces.

Specially heat-treated tool steel makes OK Ways practically wear-proof. Extreme hardness (65-66 Rockwell C) is uniform to a 3/16-inch depth or more. This is welded to a soft, tough steel backing under 2500 tons pressure, then precision ground to ±.0002 inches. OK Hardened Ways are available in a variety of shapes and sizes or can be made to suit your requirements.

THE G. A. GRAY CO. is one of many Machine Tool Show Exhibitors using OK hardened products as components. Look for OK products on machines at the big Show. They are a good index to over-all machine quality.

For free Ohio Knife bulletin, showing seven standard cross-sections in over 60 sizes, write Dept. 43-A



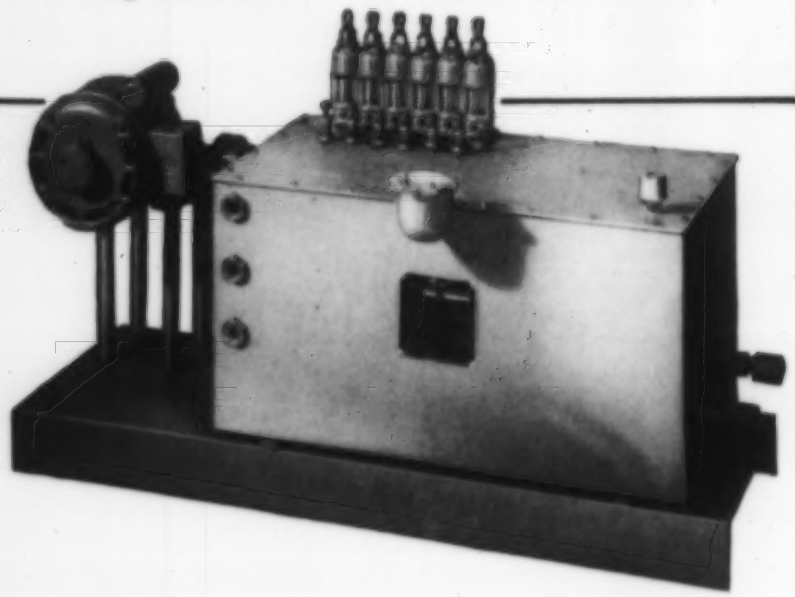
Slitter Knives • Shear Blades • Work-Rest Blades • Cut-Off Blades • Hardened Spacers • Hardened Ways • Gibs • Ball Races • Bronze Ways • Wear Strips

THE OHIO KNIFE CO.

CINCINNATI 23, OHIO

MANZEL

Has a Long Record of Successfully Doing the "Impossible" in Lubrication



Manzel engineers repeatedly provide dependable, automatic lubrication where others said it couldn't be done.

Whether your requirements are in the "impossible" category — or as simple as they can be — ask Manzel to work with you in building dependable, automatic lubrication into the equipment you design.

Manzel Force Feed Lubricators

Deliver the exact amount of lubricant required, at precisely the right places, and at accurately-timed intervals. There are models to operate against pressures up to 30,000 psi. When it's a question of how best to lubricate, always call Manzel.

Special Quality Features of Manzel Lubricators

- Completely protected with Parco Lubrite
- Rust resistant reservoirs
- Closer fitting plungers made possible by special precision equipment
- Gears of harder alloy for longer wear
- Every unit factory tested before shipment

Manzel

Professionally qualified engineering representatives throughout the country.

DIVISION OF

HOUDAILLE-HERSHEY CORP.

276 BABCOCK ST., BUFFALO 10, N. Y.

ENGINEERING DEPARTMENT

EQUIPMENT

Portable Tracing Table

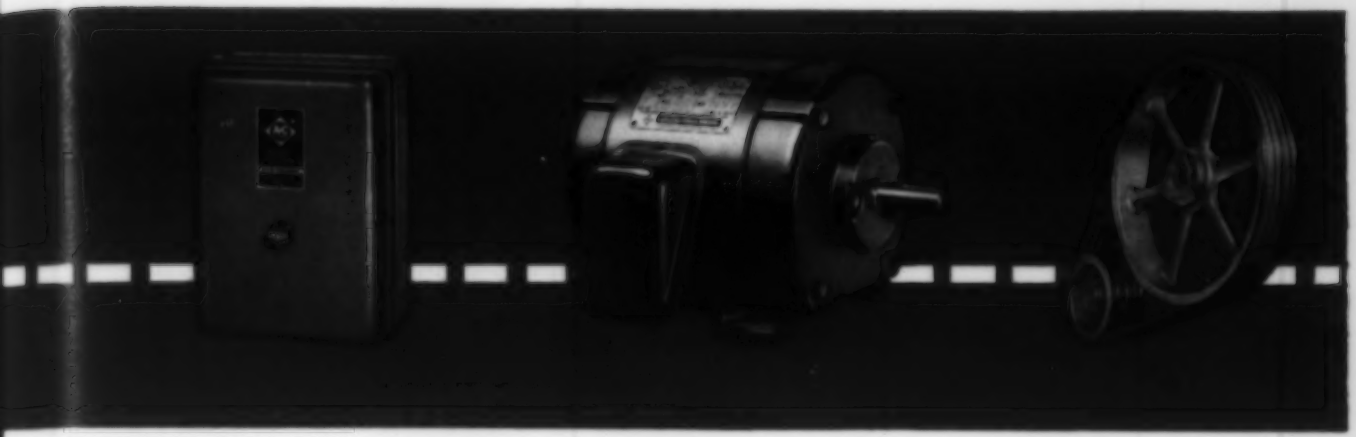
Designed for use on a drawing board, the Porta-Trace tracing table is 1⅜ in. high. It can be used under a standard straightedge or drafting machine. Low height and flush top permit tracing drawings larger than the unit. Held in position, even at acute angles, by rubber feet, the table is

easily moved to permit drawing at various angles. Illumination sufficient to permit tracing on Bristol board is furnished by fluorescent lamps mounted in the frame. A Plexiglas top provides light diffusion with minimum glare. A glass top is also available. Four models of the Porta-Trace are available with tracing surfaces ranging in size from 15¼ x 17¼ to 23¼ x 35¼ in. Made by **A. F. Gagne Jr. Associates**, 11 Chestnut St., Binghamton, N. Y.

For more data circle MD-113, Page 215

Draftsman's Desk

An endless vinyl plastic belt on the drafting platform of the Draft-A-Matic desk can be moved, with a drawing affixed to it, so that the drawing remains within the range of visibility and reach of the draftsman. Rollers located at the front and back of the platform control belt position. The belt is



...Simplify Service

These Components are Designed to Work Together and They're Backed by Nation-Wide Service

Save design time, cut manufacturing costs using Allis-Chalmers matched motors, control and V-belt drives. You're sure of efficient power train design when you use coordinated components . . . all of one manufacture. Engineering and matching of parts is done for you by Allis-Chalmers.

Get Nation-Wide Service. Allis-Chalmers continues to serve you after your equipment is installed. In addition to 76 district offices, there are almost one hundred Certified Service Shops located in every industrial area in the country. These shops are carefully selected, independent shops that use only factory-approved parts and methods in servicing Allis-Chalmers equipment.

For an experienced specialist to help you select the best drive for your machine . . . for coordinated equipment . . . call your nearby A-C District Office, or write Allis-Chalmers, Milwaukee 1, Wisconsin.

Send for FREE engineering literature

Control

Handy Guide to Starters	14B7733
Reduced-Voltage Starters	14B7215

Motors

Handy Guide to Motor Selection	51B6052
Squirrel-Cage Motors	51B6210
TEFC Motors	51B7225

Texrope Drives

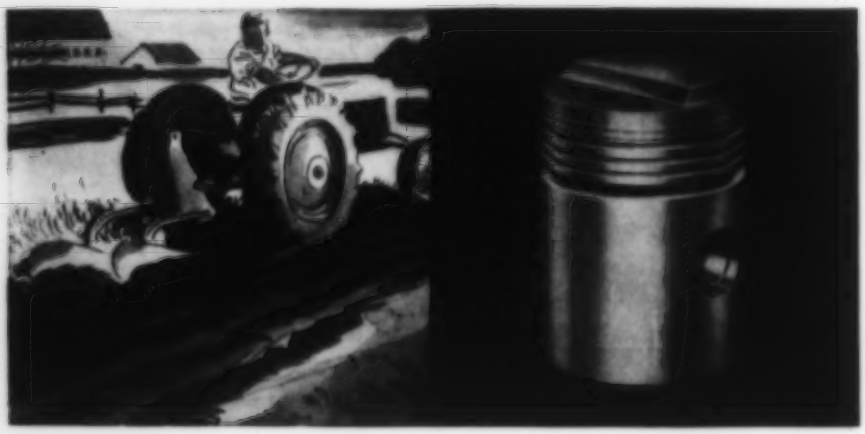
Handy Guide to *Texrope* Drives	20B6051

CHALMERS

Texrope is an Allis-Chalmers trademark.

A-C ALLIS-CHALMERS

Fishing and Farming



Thompson Precision-Engineers Light Metal Castings for All Industry

THE fisherman trolling for the big one and the farmer working his south forty have one thing in common—both can count on Thompson. The fisherman's outboard motor and the farmer's tractor engine are each improved by precision-engineered castings produced by Thompson's versatile Light Metals Division.

In the case of the tractor, it's any one of several parts, including the piston, that is produced by Thompson — with the outboard motor, one of the parts produced by Thompson is the propeller.

Outboard motor propellers and tractor engine pistons are but two of the many light, strong, durable castings designed, developed and manufactured by Thompson for a diversified list of customer uses. Today Thompson is producing light metal castings for such products as buses and garbage disposers; washing machines and jet planes; automobiles and industrial engines; ice scoops and aircraft engines.

Behind this ability to aid all forms of industry are over 50 years experience in research and manufacture of precision metal parts. Regardless of your product, if you use castings, Thompson's creative engineers will gladly show you where and how you can simplify your operations and save on costs with Thompson Light Metals Castings.

For a detailed description of the Thompson Light Metals facilities which are available to you, send for your free copy of "Creative Castings." Just write to Dept. M-3, Light Metals Division, Thompson Products, Inc., 2269 Ashland Road, Cleveland 3, Ohio.

You can count on

Thompson Products

LIGHT METALS DIVISION
2269 Ashland Rd. • Cleveland 3, Ohio

Engineering Equipment

(*Continued from Page 275*)

Auto-Scan accessory for mechanical scanning. Bottom throat design makes possible insertion of cards at desk level. A ventilating system prevents heat damage to film and cards. Reader is available with 16, 24 and 30X magnifications. Made by **Dexter Folder Co.**, Filmsort Div., Pearl River, N. Y.

For more data circle MD-115, Page 315

Drawing Ink

Electropolarized ink, uniform in color throughout the bottle, does not require shaking before use. Pin-point applicator of the squeeze-bottle container speeds pen or instrument filling without spilling or drying out. It facilitates applying the proper amount of ink and permits utilization of the bottle's entire contents. Made by **Carter's Ink Co.**, 239 First St., Boston, Mass.

For more data circle MD-116, Page 315

Template File

A system for filing and storing templates, patterns, gaskets and flat tools, the Templa-File contains twenty-four 36 x 80-in. numbered sliding panels. Each panel is suspended on rollers which operate on tracks. Storage area of the unit is 2880 sq ft. Each panel will support 600 lb of suspended weight. A self-contained record or reference desk folds back into the unit when not in use. A swing-out tabulating card file is attached to the desk. File occupies less than 25 sq ft of floor area. Made by **DeLuxe Metal Furniture Co.**, 306 Struthers St., Warren, Pa.

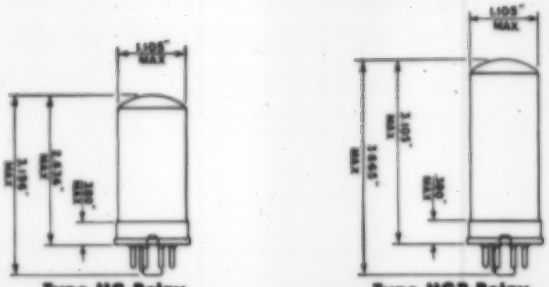
For more data circle MD-117, Page 315

Does a

Billion Operations

-with no maintenance-

interest YOU?



Type HG Relay

Type HGP Relay

New CLARE Mercury-Wetted Contact Relays meet ALL requirements of today's high-speed switching devices

• If you design high speed switching machines or devices which demand accuracy and dependability of the highest order, you should know ALL about the new CLARE Mercury-Wetted Contact Relays.

CLARE Type HG and HGP Relays offer a combination of high speed, high current- and voltage-handling capacity, and extraordinary uniformity of performance over very long periods.

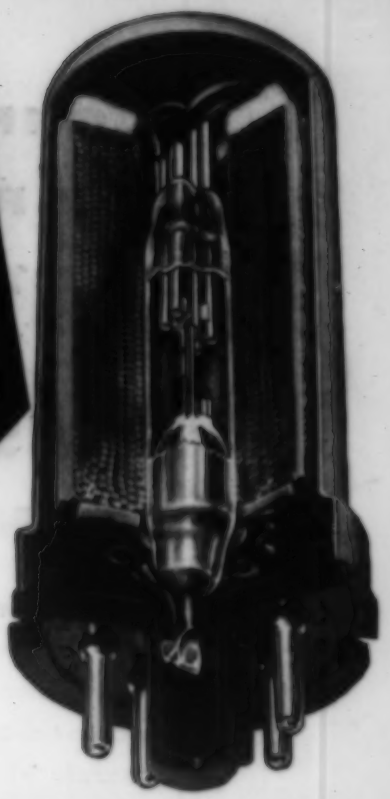
The relays consist of a magnetic switch, hermetically sealed in a high pressure hydrogen atmosphere in a glass capsule, and a coil, enclosed in a steel vacuum-tube-type envelope which has a standard medium-sized octal base. Platinum contact surfaces are continually wetted with mercury by means of a capillary connection to a mercury reservoir below the contacts. Type HGP Relays can be factory-adjusted to provide either biased or polarized operating characteristics.

For complete information on the new CLARE Type HG and HGP Mercury-Wetted Contact Relays, contact your nearest CLARE representative or address C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois.

Send for CLARE Sales Engineering Bulletin No.120

CLARE RELAYS

***FIRST* in the industrial field**



• Cutaway view of HG Relay showing how wick action keeps the mercury at the contacting surfaces continuously replenished.

CLARE Type HG and HGP Relays are built to meet the exacting requirements for—

Computing machines	Servo-mechanisms
Sorting machines	Relay amplifiers
Tabulating machines	High-speed keying relays
Totalizers	Signaling devices

All kinds of high-speed switching devices

Outstanding features of CLARE Type HG and HGP Relays

ELECTRICAL FEATURES

LONG LIFE: Conservative life expectancy of over a billion operations when operated within ratings.

HIGH SPEED: Give consistent performance at speeds up to 60 operations per second.

HIGH CURRENT—and voltage-handling capacity (up to 5 amperes, and up to 500 volts).

UNIFORMITY: Operating time varies by only about 0.1 millisecond under constant drive conditions.

NO CONTACT BOUNCE

MECHANICAL FEATURES

- Small chassis space required
- Convenient plug-in mounting
- Environment-free
- Tamperproof
- High sensitivity
- Maintenance-free
- No contact wear
- Adjustment cannot change

for TOUGHNESS
WEAR RESISTANCE
IMPACT

specify AMSCO®
MANGANESE STEEL

- nonmagnetic
- resists impact
- high strength
- work-hardens
- resists abrasion
- high ductility
- slow crack propagation
- low temperature toughness

Manganese steel actually *absorbs energy.* Impact work-hardens the surface of the metal to as high as 550 BHN, while below the surface it maintains its ductility. Roughest abrasion only polishes this versatile metal.

Another highly desirable feature is manganese steel's slow crack propagation rate. This is a built-in safety factor, allowing early discovery of impending failure so that remedial action can be taken before costly damage or breakdown occurs.

Amsco manganese steel, being an austenitic structure, remains tough at low temperatures, retaining a valuable safety factor even at cold −100°F.

All of its characteristics, including a complete discussion of its technical aspects and inherent design features are contained in the Amsco booklet, *Austenitic Manganese Steel.* It's free. Send for your copy today.

AMERICAN Brake Shoe COMPANY

AMERICAN MANGANESE STEEL DIVISION
Chicago Heights, Illinois

Stress Relief

THE boss, too, has his problems. J. P. Henderson comes to his aid this month, waving the campaign banner:

Slaves, Unite!

With time on my hands I've dropped in on some old cronies occasionally. The other day I found one in distress.

"J. P.," he says, "you've been reading a lot about unions in the engineering profession. Well, I'm about ready to go a step further. I'm ready to advocate a union for engineering executives!"

"You're not serious?" I replied.

"I'm darn near," he retorted.

To shorten a long conversation, his story was this: Looking back, he felt as though most of his professional life he had been fighting management for this or that. As an engineering executive, he *was* management—to people below him. But naturally he was responsible to the president and, in a remote way, the board of directors. In his experience none of these people had had any engineering training. None really understood the nature of his problems. They gave all engineering expenses the glassy eye. To obtain technical equipment, he had to spend days preparing arguments, trying to explain what it was for, and how it could save the company money.

"How do you justify a $2000 scientific instrument for our experimental laboratory to a banker?" he asked. "Its use will help get us out of some troubles faster, if they develop. In an obscure way it will help improve our product. It may enable our engineers to see more clearly how our gadgets are behaving and should lead to better and more economical design. But can I *guarantee* that this expenditure will definite-

where 99.9% reliability isn't enough—

Vitrohm

resistors take over

There are cases where you can't play it too safe

In ground-to-air guided missiles, high-powered walkie talkies, radar trucks, experimental rockets, atomic subs, console control panels – any instrument requiring high accuracy and dependability – you'll find Ward Leonard Vitrohm resistors.

You'll also find them in hundreds of commercial and industrial applications where the variety, performance, and uniformity of Vitrohm resistors have added up to increased customer satisfaction, repeat sales and substantial savings on repairs and returned merchandise.

FOR MILITARY APPLICATIONS, the Vitrohm resistors designed to meet MIL-R-26B specs (characteristics F, G and V) are listed in our TECHNICAL INFORMATION CIRCULAR #1.

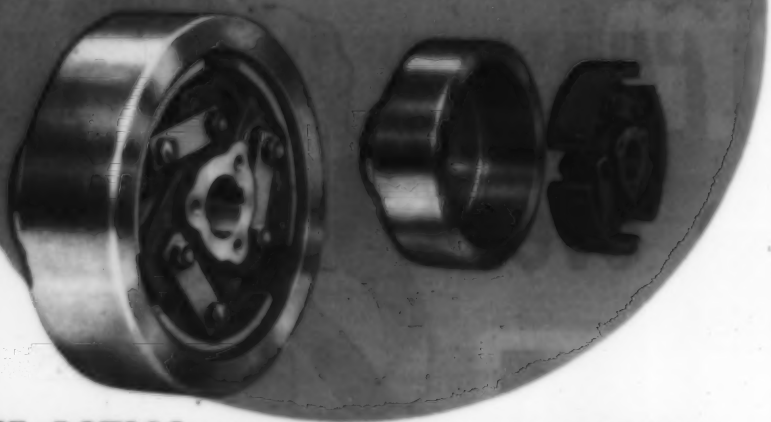
FOR ELECTRICAL AND ELECTRONIC APPLICATIONS, our 64-page fact-jammed Catalog #15 gives you the complete Vitrohm story. Write Ward Leonard Electric Company, 58 South Street, Mount Vernon, N.Y.

WARD LEONARD ELECTRIC COMPANY

MOUNT VERNON, NEW YORK

Flexible ACTION IN THE New HILLIARD TWIFLEX

AUTOMATIC CENTRIFUGAL CLUTCH COUPLING



11 NEW IMPORTANT FEATURES..

1. Flexible in all directions.
2. Absorbs Shock.
3. Limits torsional vibration.
4. Has adjustable idle speed.
5. Can be furnished in automatic free-wheeling type.
6. Smooth starting.
7. No slip under normal load at full speed.
8. Protects driver and driven mechanisms against overload shock.
9. Can be furnished in automatic backstop type.
10. Prevents torsional resonance.
11. Easily assembled even in blind installations.

If you have problems of misalignment — smooth starting — vibration — overload — or assembly in the manufacture or operation of:

- Compressors
- Blowers
- Diesel Engines
- Excavators
- Refrigeration
- Hammer Mills
- Textile Machinery
- Wire Machines
- Fans
- Gasoline Engines
- Back Stop Brakes
- Mixers
- Conveyors
- Pumps
- Electric Motors
- Generators
- High Speed Pulverizers
- Tube Mills

• Let Our Engineers Consider Your Problem. Twiflex May Be The Answer.

SINGLE REVOLUTION CLUTCH

For automatic, accurate control, electrically or mechanically, of intermittent motion, indexing, cycling, cut-off. Write for Bulletin # 239.

OVER-RUNNING CLUTCH

For automatic engagement and release on two speed drives, dual drives and for ratchet feed or backstop action. Write for Bulletin # 231.

SLIP CLUTCH

For overload protection—constant torque—constant tension on reeling or winding stands. Write for Bulletin # 300.

WRITE TODAY! For Details of TWIFLEX Coupling in Catalog CE-3

THE HILLIARD Corporation

103 W. FOURTH ST. ELMIRA, N. Y.

MANUFACTURING CLUTCHES FOR 50 YEARS

ly save us, say $500 per year? Of course not.

"My bosses have always believed in science and engineering—in a vague sort of way. But they have no real idea of what it should cost at any time, and in this age of rising prices I'm having a doubly hard time in stretching my engineering dollar to keep pace with our competitors.

"What percentage of total sales should be spent on engineering and product improvement? What percentage should be spent in applied research? I know our own past figures, but are they in line with other concerns of this size and type? I don't know.

"How much is a good designer worth? I've interviewed men recently whom we need badly. Their salaries seem astronomical to the president and he can't bring himself to OK their hiring. So I limp along, until in a year or two my educational campaign on current salaries will finally bear some fruit with him."

I asked him if he was required to run to the president with all such hiring problems and matters of expenditure. He said that he actually enjoyed considerable freedom. The boss wasn't a tyrant especially, but expected only expenditures in big lumps, or high-priced hiring, to have his blessing.

"My other gripe," said he, "is development. Let anybody in my department come up with a good idea and the president expects it to be ready for the market in a month. I have never been able to satisfy him that it may be perfectly normal for the first sample to be a failure. From it we learn something, make more temporary tools and produce a modified sample. That sort of thing interspersed with some life tests may go on for a year before we are ready to risk our reputation in the field. We have worked with our customers on jobs for three years or even four. I understand their problems and the time doesn't seem excessive. But can I convince him that such things are normal?

"No sir! From conception to

full maturity of a highly technical development should be just a matter of weeks.

"I tell the boss that if engineering development were that easy everything would have been invented years ago. But I make no impression. So now I'm ready to join the EESMPANP."

"It's the Engineering Executives' Society for Mutual Protection Against Nontechnical Presidents."

"Just think," he said with a dreamy look in his eye. "As a member of such as active organization I could get all kinds of data. Protective data. We'd know each others' salary scales for various grades of engineering work. We'd know what each other considers as normal engineering and development expenditures and their relation to sales. We'd know about laboratory budgets and all sorts of things.

"I'd feel free to call up one of my competitive friends and find out just how many man-hours they spent on that new product they're advertising and how long it was in development.

"Then when I went to the boss to ask for stuff, I could rattle off data and figures galore. Figures impress bankers and I might get engineering appropriations with a lot less time and effort. As an engineering executive, I might get to spend some time on engineering."

I left about then. How fantastic can a dreamer get?

—J. P. HENDERSON

They Say . . .

"No responsible engineer or scientist allows his fancy such free rein as to assume that he can change Newton's law of motion or find profitable exceptions to the second law of thermodynamics.

"Imagination untempered by an appreciation of harsh realities may create poetry, but it will never create a nuclear power plant, ship or rocket."— CLIFFORD MANNAL, *physicist, Knolls Atomic Power Laboratory*

Everyone recognizes this as a sign of smooth sailing . . .

And smart gear users know this CINTI is the sign of *good* gears made to *your* specifications.

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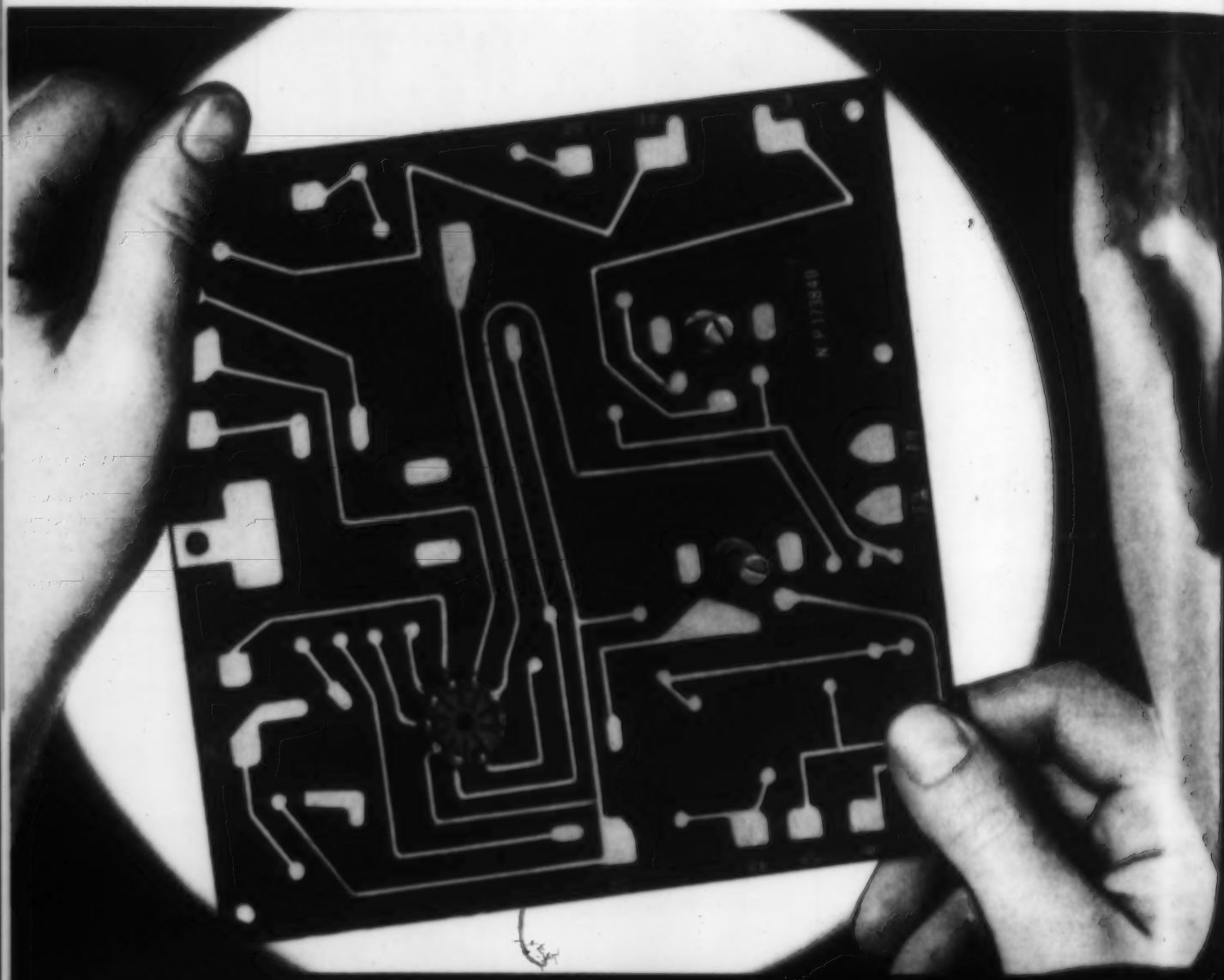
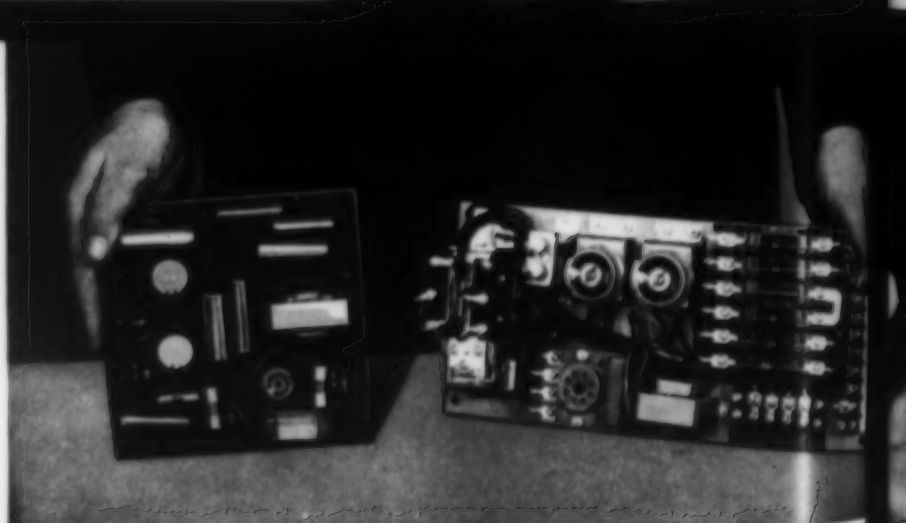
GENERAL ELECTRIC ANNOUNCES . . .

NEW, Low-price Thy-mo-trol*



Printed Circuits—or "wireless" circuitry—constitute the "brains" of the new general purpose Thy-mo-trol Drives. Simply, it is a method of printing an electrical diagram on the back of a sturdy, lightweight plastic board. The electrical "track" or diagram is made of solder-covered copper strips.

All circuit components within the "brain" are connected without the use of wiring! A protective coating is sprayed over the entire printed circuit. All connections to the control circuits are of the simple "plug-in" type, making attachment and removal of connecting circuits a simple, hand operation.



"Brain" of new Thy-mo-trol Drive—printed control circuits. Top photo shows printed electrical diagram. G.E.'s industrial adaptation of this process helps reduce size and complexity of circuits. In lower photo, new at left, conventional at right.

Drive with Printed Control Circuits

NOW! GET RELIABLE, SMOOTH, ADJUSTABLE SPEED FOR MACHINE TOOLS IN A SIMPLIFIED, LOW-PRICED DESIGN

Designed for quality performance, reliable operation, easy maintenance, and at a new low price, a new and simplified line of general purpose Thy-mo-trol Drives has been developed by General Electric. These drives represent a new and far-reaching step in electronic adjustable speed.

An approximate 20% price reduction under the line it replaces is possible because G-E has successfully simplified the entire control system and has adapted printed control circuits into the Thy-mo-trol panels. New Thy-mo-trol design allows a substantial reduction in *weight, size, circuit complexity, wiring, maintenance costs and installation cost.* The new design is now available in two ratings: ¾ to 1 hp and 1½ to 3 hp—making your choice of an adjustable speed drive to meet specific needs that much easier.

Operating directly from a-c power, the new standard Thy-mo-trol Drive includes an electronic control panel, a d-c motor, and a push-button station. No anode transformer is necessary if operated on 440 volts, 50 or 60 cycle, single phase power. Separately mounted auto-transformers are supplied as a standard feature for voltages other than 440.

The new drive is rated at constant torque over the entire speed range. Speed range is 8 to 1 for continuous duty with higher ranges possible for special applications. Optional modifications include jogging, reversing, tachometer feedback, reactor loop control, and external current limit adjustment.

For more information on this outstanding new adjustable speed drive, contact your nearest G-E Apparatus Sales Office or write for Bulletin GEA-6234, General Electric Company, Section 791-1, Schenectady 5, New York.

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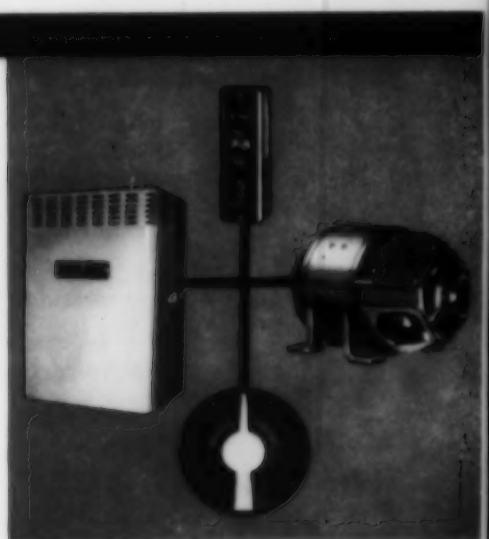
Easily attached or removed. Only a screwdriver is needed. Plugs and terminals are numbered for easier service.

Simplified repair. Component replacement is fast and easy—a simple bench operation. No need to discard entire unit.



Three basic units. DC motor, pushbutton station, and panel containing tubes and "brain" make up new Thy-mo-trol Drive.

Parts for this piston and sleeve assembly were mated and lapped to a precision fit. Clearance tolerances were maintained on the assembly to less than .00006". Inside diameter, concentricity and grooves were also held to very close tolerances.

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Recent Books

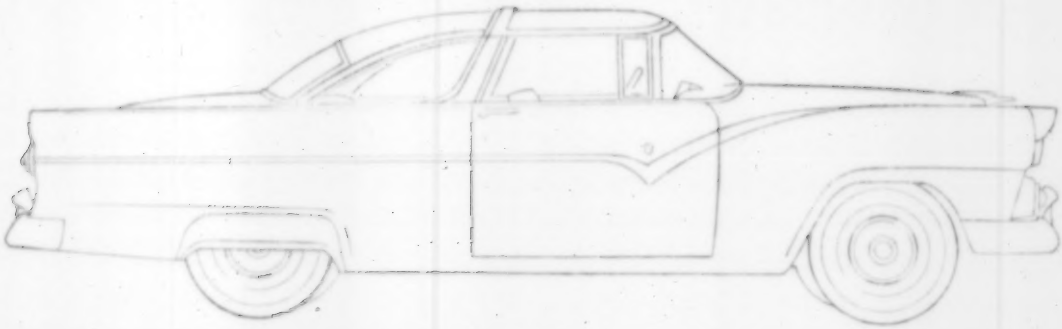
Advanced Mathematics for Engineers. *By H. W. Reddick, retired professor of mathematics, New York University, and F. H. Miller, professor and head of mathematics, Cooper Union School of Engineering;* 562 *pages,* 5½ *by* 8½ *inches, clothbound; published by John Wiley & Sons Inc., New York; available from* MACHINE DESIGN, $6.50 *postpaid.*

This third edition covers topics in mathematics which are essential for an understanding of current developments in engineering theory and practice. The book opens with a chapter on common types of ordinary differential equations. Succeeding chapters give a comprehensive treatment of operational calculus, Fourier series, partial differential equations, vector analysis, elliptic integrals, gamma and Bessel functions, and functions of a complex variable. Included in the new material are discussions of Legendre's equation, numerical methods, Laplace transforms and the reversion of power series.

•

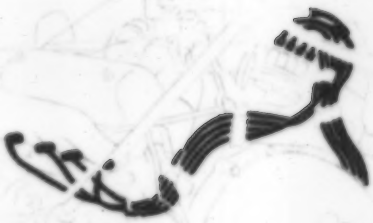
The Strain Gage Primer. *By C. C. Perry, research consultant and assistant professor of engineering mechanics, and H. R. Lissner, professor and chairman, department of engineering mechanics, Wayne University;* 293 *pages,* 6 *by* 9 *inches, clothbound; published by McGraw-Hill Book Co. Inc., New York; available from* MACHINE DESIGN, $6.00 *postpaid.*

Serving as a practical guide to methods of using strain gages, this book covers experimental stress analysis, with emphasis on bonded-wire strain gages, their appearance, composition, manufacture and operating characteristics. It includes a section on use of the strain gage as a transducer element for instrumenting and controlling countless mechanical vari-



Under the hood of the smart new Ford . . .

Neoprene protects ignition wire and spark plugs against moisture . . . resists ozone, heat and oil



Designers made sure the smart-looking 1955 Ford would be off to a fast start in any weather. On both the "Six" and the "Eight" they chose spark-plug covers and ignition-wire jackets made with neoprene for positive protection against moisture and deterioration.

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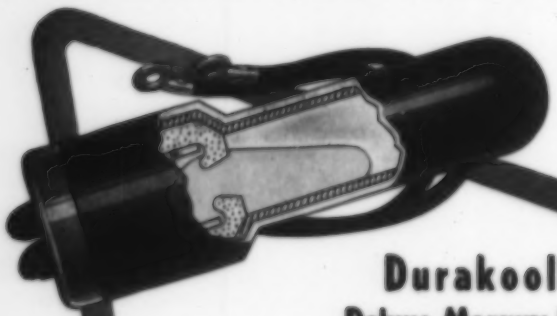

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Areas of the subject treated in detail include selecting the proper strain gage for a particular job, cementing, damage-proofing and wiring the gage, selecting and using the right instrument, and interpreting the strains and their translations to stresses.

In addition, there are examples of the stress-strain relation, techniques for measuring principal stress directly, information on latest types of American and foreign strain gages and their properties, data on use of strain gages under special conditions and extreme temperatures, advances in techniques for damage-proofing, and an instrumentation chart to aid in selecting the proper system. The concluding chapter discusses strain indication with brittle coatings.

•

Deterioration of Materials—Causes and Preventive Techniques. *Edited by Glenn A. Greathouse, director, and Carl J. Wessel, associate director, Prevention of Deterioration Center, National Academy of Sciences—National Research Council, Washington, D. C.; 853 pages, 6 by 9 inches, clothbound; published by Reinhold Publishing Corp., New York; available from* MACHINE DESIGN, *$12.00 postpaid.*

A collaboration under joint auspices of the Prevention of Deterioration Center and the Services Technical Committee of the Department of Defense, this book describes and analyzes causes of deterioration in materials and presents proved techniques for preventing or retarding such deterioration. Part 1 deals with basic causative agents in materials deterioration—climatic factors and chemical, physical and biological agents. Part 2 is concerned with the action of these agents on materials of various kinds and with specific methods of deterioration prevention. Part 3 discusses protection of certain important assemblies of electrical, electronic, optical and photographic equipment. Part 4 covers some special aspects of preservation, including

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approved methods of packaging and toxicological aspects of preservatives. Appended is a short analysis of the system of Government specification numbers.

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Conversion Factors and Tables. *By O. T. Zimmerman, professor and chairman of chemical engineering, and Irvin Lavine, professor of chemical engineering, University of New Hampshire;* 525 *pages,* 4¼ *by* 6 *inches, clothbound; published by and available from Industrial Research Service, Masonic Building, Dover, New Hampshire,* $5.00 *per copy.*

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New Codes

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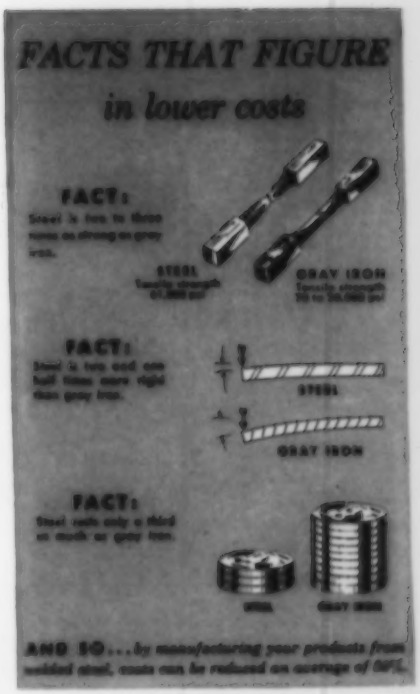

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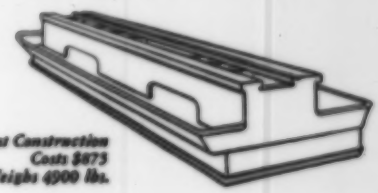

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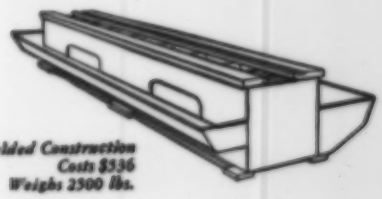

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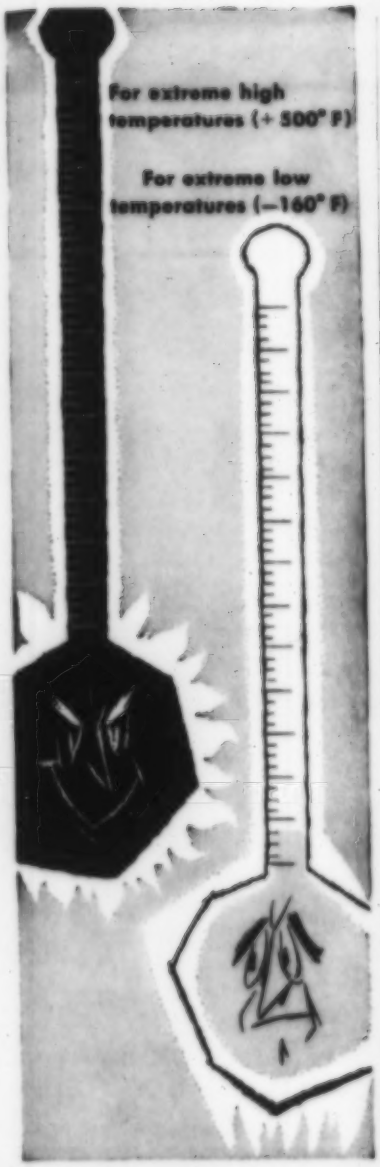

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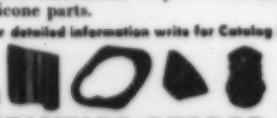

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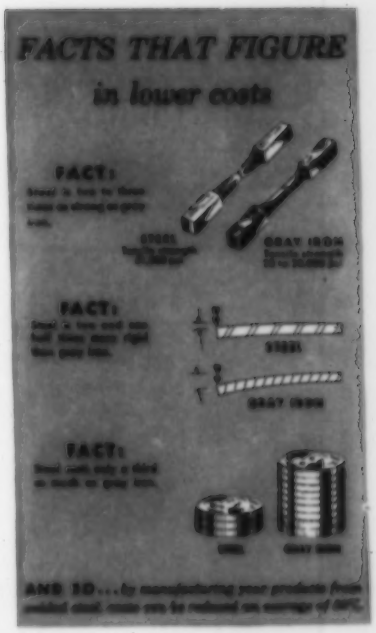

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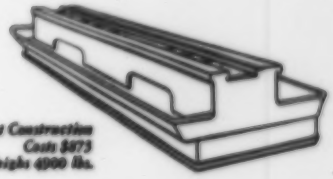
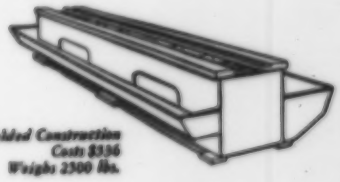


Cast Construction Costs $673 Weighs 4900 lbs.



Welded Construction Costs $334 Weighs 2500 lbs.

PUT THESE BENEFITS TO WORK—Ideas on designing for low cost with steel are in Lincoln WELDesign Bulletins, available to designers and engineers. Write:

THE LINCOLN ELECTRIC COMPANY
Dept. 1105, Cleveland 17, Ohio

The World's Largest Manufacturer of Arc Welding Equipment

Engineered RELAYS for Engineered Products

"Your best source for relays" is Potter & Brumfield, because of an enviable reputation earned through a *quarter century* of relay specialization.

Millions of relays of *all styles* and *sizes* designed and manufactured to meet customer specification.

From small sub-miniature, precision, sensitive relays to heavy duty power types, each fulfilling an exacting requirement.

Enclosed, hermetically sealed or open relay structures to meet demands of various environmental conditions.

Priced competitively at all quality levels. Samples available for immediate shipment. Send your specification for recommendations and quotations.

ALL TYPES—ALL SIZES—FOR ALL APPLICATIONS

discriminating

~~most~~ engineers choose Potter & Brumfield

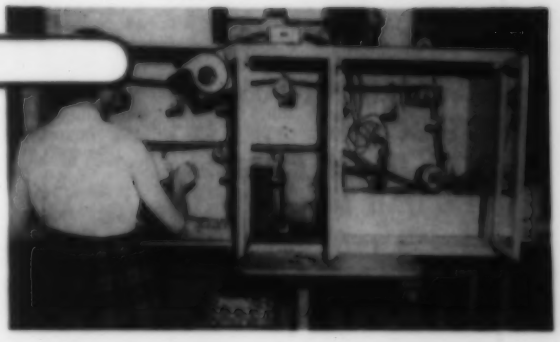
100% HI-POT TEST

Some sealed relays have as many as ninety possible voltage breakdown points. This tester, developed by Potter & Brumfield, checks every breakdown point automatically with extra high voltage and for the necessary time interval.

ULTRASONIC CLEANING

Another Potter & Brumfield development, the use of Ultrasonic cleaning in relay manufacture.

Potter & Brumfield sealed relays are tops because they are thoroughly cleaned of all dirt, solder flux and other contaminants by silent sound.



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Thus assuring the close tolerances necessary for long life and dependable operation of miniature and sub-miniature relays.

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ALL TYPES—ALL SIZES—FOR ALL APPLICATIONS

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ENGINEERED for DOUBLE-DUTY!

A REVERSING DRUM CONTROL with . . . BUILT-IN THERMAL OVERLOAD UNIT . . at a lower cost To You!

Only Furnas Electric offers you this exclusive feature. *Costs less than one-half what you would pay for manual reversing starters to perform the same job.*

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BATAVIA, ILLINOIS

The Engineer's Library

(*Concluded from Page 295*)

Effect of Temperature on the Properties of Metals.

•

Symposium on Effect of Cyclic Heating and Stressing on Metals at Elevated Temperatures. *ASTM Special Technical Publication No. 165; 181 pages, 6 by 9 inches, paperbound; available from American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., $3.00 per copy.*

This booklet comprises eight papers and accompanying discussions presented at the 57th annual meeting of ASTM in June, 1954. The symposium covers situations involving relatively slow changes in stress or temperature, or both. Two papers cover various theoretical aspects including creep under intermittent load and cyclic thermal stresses. Three papers discuss creep and rupture data. Two papers present intermittent load and temperature data for some alloys in sheet form. The final paper deals with effect of cyclic temperatures on scaling behavior of heat-resisting alloys.

Government Publications

NACA Technical Series. *Each publication is 8 by 10½ inches, paperbound, side-stapled; copies available from National Advisory Committee for Aeronautics, 1924 F St., N. W., Washington 25, D. C.*

The following Technical Notes are available:

3216. **Cooperative Investigation of Relationship between Static and Fatigue Properties of Wrought N-155 Alloy at Elevated Temperatures**—62 pages.

3295. **Effect of Pressure on Thermal Conductance of Contact Joints**—52 pages.

3355. **Theory of the Jet Syphon**—49 pages.

3430. **Analysis of Ear Formation in Deep-Drawn Cups**—7 pages.

3444. **Friction, Wear, and Surface Damage of Metals as Affected by Solid Surface Films**—60 pages.

3445. **Design and Performance of Throttle-Type Fuel Controls for Engine Dynamic Studies**—39 pages.

3446. **Theoretical Analysis of Incompressible Flow through a Radial-Inlet Centrifugal Impeller at Various Weight Flows. I—Solution by a Matrix Method and Comparison with an Approximate Method**—39 pages.

3449. **Theoretical Analysis of Incompressible Flow Through a Radial-Inlet Centrifugal Impeller at Various Weight Flows. II—Solution in Leading-Edge Region by Relaxation Methods**—19 pages.

3450. **Preliminary Investigation of Properties of High-Temperature Brazed Joints Processed in Vacuum or in Molten Salt**—25 pages.

ELECTRICAL and MECHANICAL ENGINEERS

AC AND DC SUBFRACTIONAL MOTORS
SERVOMECHANISMS
ELECTROMECHANICAL AND ELECTROHYDRAULIC
CONTROLS AND ACTUATORS

We are now staffing the new Electronics Laboratory of our Aeronautical Division in Anaheim, California. The selection of associates is based on consideration of their demonstrated abilities and interests in connection with our long-range laboratory plans. Careful attention to engineering and operational planning and to the selection of critical control problems assures opportunities for continuous professional development. The efforts of a relatively small but select staff are being applied on projects requiring engineering ingenuity essential to advancing the art of control in the aeronautical field.

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Positions are available at all levels of laboratory work. Please direct inquiries to Vernon Vogel, Electronics Laboratory Director.

Aeronautical Division
Robertshaw-Fulton CONTROLS COMPANY
SANTA ANA FREEWAY AT EUCLID AVENUE
ANAHEIM, CALIFORNIA

NOTEWORTHY

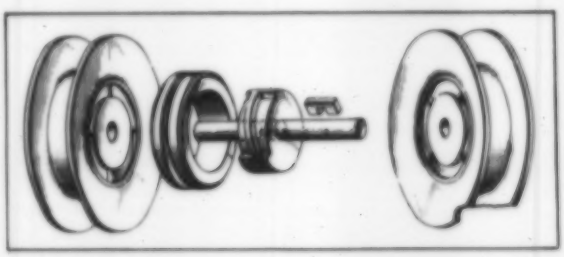
Patents

Pressure Operated Seal

Fluid pressure acting on a high-temperature sealing ring for turbine or similar rotors forces the seal into engagement only when the turbine is operating. One edge of the seal is pressed into a chamber that is ported to the upstream side of the turbine. Operating pressure within the chamber forces the resilient seal against a conical surface of the turbine diaphragm. As a result, the seal is forced downward into sealing engagement with the turbine rotor. When the machine is not operating, pressure does not exist and the seal is free to move away from the rotor. Seizing of the seal on the rotor due to differential contraction of the turbine parts when the machine is cooling is eliminated, thus avoiding possible damage to the seal. *Patent 2,686,657 assigned to United Aircraft Corp. by A. Kalitinsky.*

Two-Direction Clutch

Two pulleys or drums may be selectively driven by merely reversing the direction of the drive shaft. Both pulleys are freely mounted on a common shaft on each side of a drive disk or hub. As the drive disk is rotated, a sliding lug, riding on a spiral ridge,



projects to engage a stepped shoulder on one of the pulleys. When rotation of the hub is reversed, the lug is forced to project from the other side to engage the stepped shoulder of the second pulley. Provision is made to hold the free pulley stationary while the other is being driven. *Patent 2,690,324 assigned to United Co-Operatives Inc. by R. B. Cooper and R. C. Shipman.*

Rotating Shaft Seal for Abrasive Liquids

An O-ring stretched over a hub on the end of the body of a shaft seal prevents leakage of low-viscosity or abrasive liquids between the end face of a rotating shaft and its housing. Sealing pressure is maintained by a spring washer between the end of the shaft and the seal body. Since the O-ring is of slightly larger

(*Continued on Page* 304)

If ENGINES are in the Picture . . . WISCONSIN would like to be on YOUR TEAM

It takes a lot of things, a lot of people, a lot of skills and experience . . . and *sound engineering* to build any kind of a machine. And above all, it takes *team-work* . . . not only in your own plant but also with the engineering departments of your *actual* or *potential* component suppliers.

Here at Wisconsin Motor we have available a great deal of specialized know-how in the design and manufacture of Heavy-Duty Air-Cooled Engines for hundreds of original equipment applications. Our engineers would like to place this experience and broad knowledge of engine design and performance at your disposal if your equipment can utilize engine power within a 3 to 36 hp. range.

It is axiomatic that no machine is any better than the power that drives it. And it is on this premise that Wisconsin Engine progress has been nothing short of phenomenal since the introduction of these heavy-duty air-cooled engines more than twenty years ago. Today our Original Equipment customer list reads like a Blue Book of American "blue chip" Industry . . . including, also, hundreds of smaller manufacturers of quality-built machines.

When you specify "Wisconsin" you get tapered main bearings, four piston rings on even the smallest models, extra-long connecting rods, rotary type high tension OUTSIDE magneto with Impulse Coupling for fast starts at low cranking speed, plus efficient AIR-COOLING from sub-zero to 140° under average operating conditions.

Why not "team up" with Wisconsin? Tell us about your problem.

4-cycle single cylinder models, 3 to 6 hp.

Single cylinder models 6 to 9 hp.

2-cylinder models 7 to 15 hp.

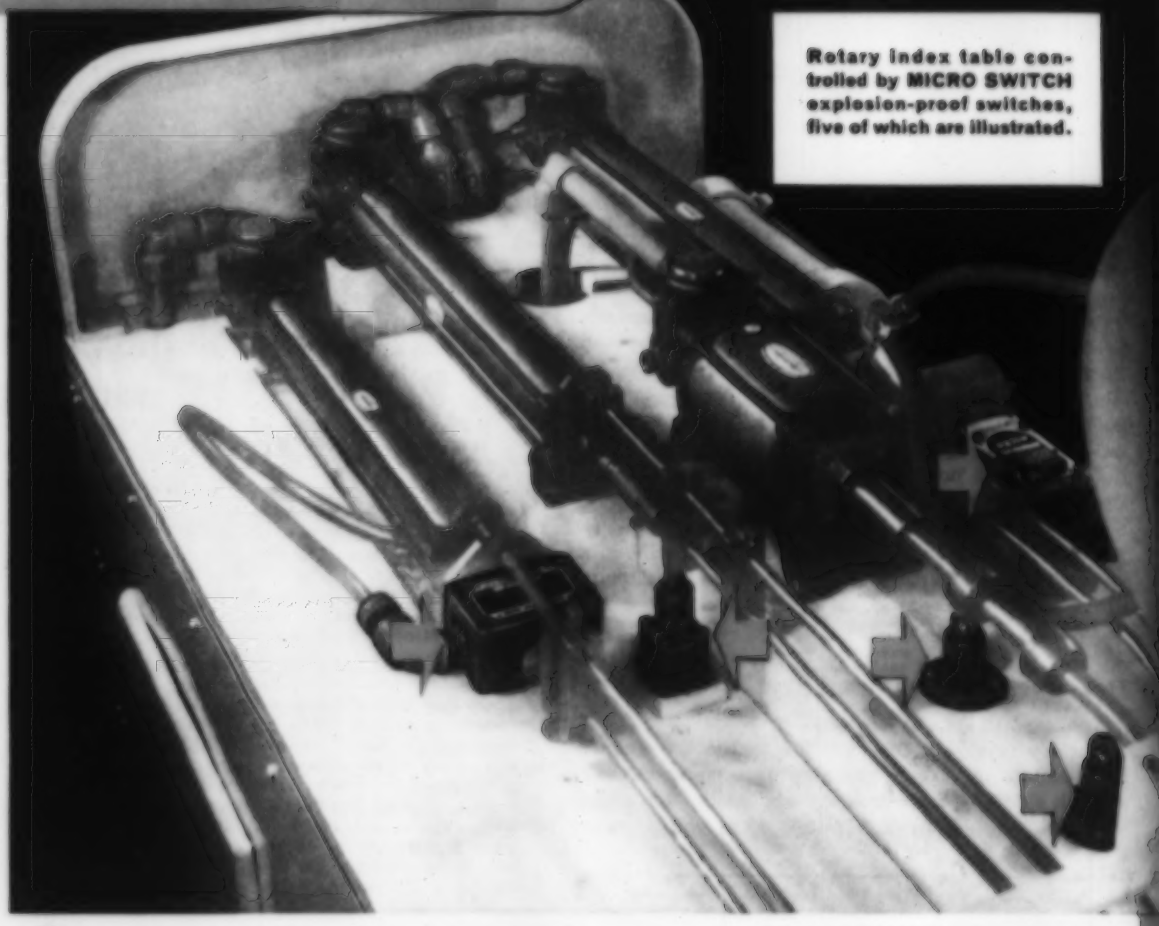
V-type 4-cylinder 15 to 36 hp.

WISCONSIN MOTOR CORPORATION

MILWAUKEE 46 WISCONSIN

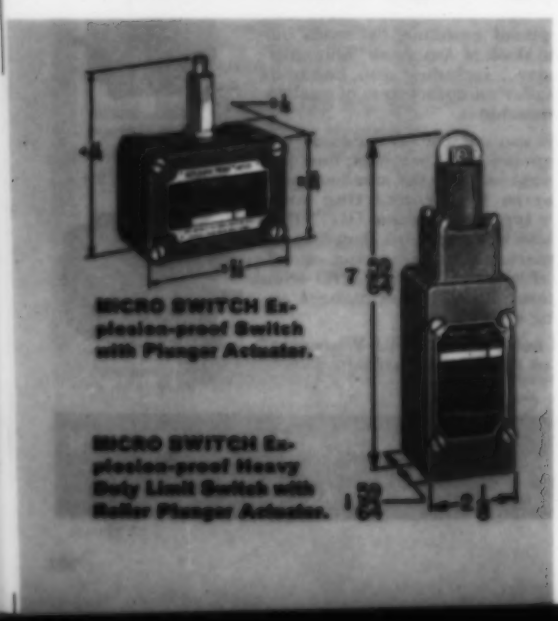
A 8665-55

MICRO SWITCH Precision Switches
A PRINCIPLE OF GOOD DESIGN



Rotary index table controlled by MICRO SWITCH explosion-proof switches, five of which are illustrated.

9 explosion-proof switches control operation cycle of Walsh Diaphragming Machine for shell primer bodies



MICRO SWITCH Explosion-proof Switch with Plunger Actuator.

MICRO SWITCH Explosion-proof Heavy Duty Limit Switch with Roller Plunger Actuator.

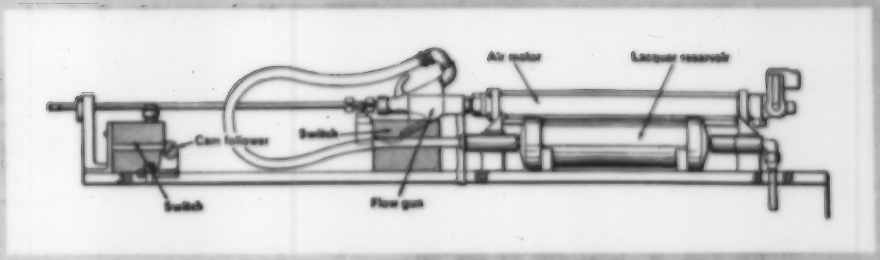
• MICRO SWITCH explosion-proof switches enable this ingenious machine to prepare primers, under hazardous atmospheric conditions, for artillery shells in one streamlined operation.

Designed by Walsh, Inc., Chicago engineering firm, it eliminates all hand work as the diaphragming machine lacquers the interior of the primer body; punches and forms diaphragms from a paper roll; seats diaphragms to proper depth and provides final inspection.

Here is a typical example of the important part played by MICRO SWITCH products in the development of automatic machinery to serve a wide range of industrial applications. Whatever your design problem, whatever your switch requirement, you will find MICRO SWITCH engineering experience a valuable ally. This cooperation will cost you nothing, can save you much.

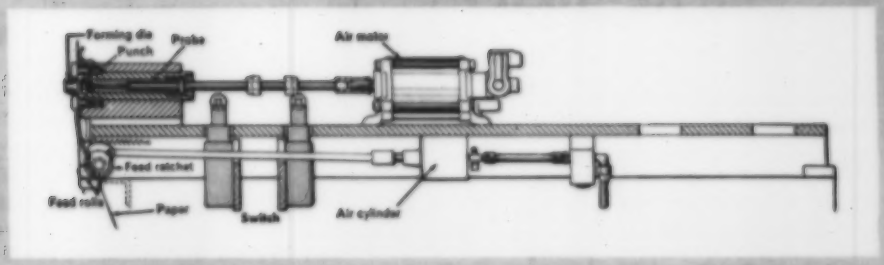
MICRO SWITCH *engineering help is as close as your telephone. Branches in 20 key cities.*

LACQUER STATION
2 SWITCHES



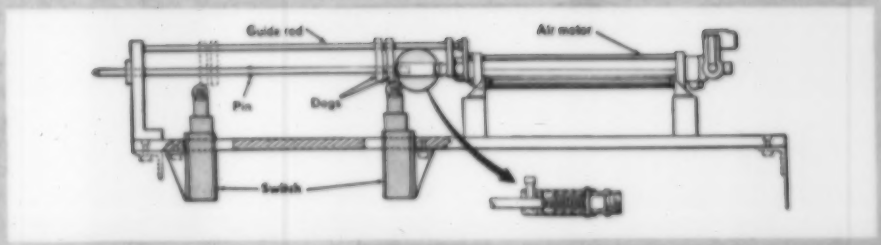
• As the nozzle approaches the surface that requires spraying, a fixed cam follower trips the control valve. Two MICRO SWITCH precision switches, horizontally mounted, control the depth of the nozzle in the tube and the pulsing of the fluid reservoir, and interlock.

INSERTION STATION
2 SWITCHES



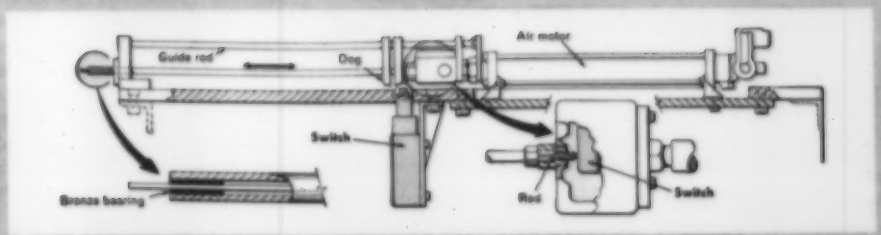
• Spring loaded punch cuts paper diaphragm before insertion probe makes contact. At the end of the cutting motion, probe continues forward and forms blank into cup shape. Final portion of the travel inserts diaphragm. The two MICRO SWITCH limit switches control the forward and back limits of travel.

SEATING STATION
2 SWITCHES



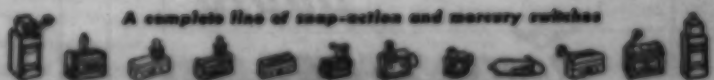
• Diaphragm is pushed to proper depth as determined by the position of the switch-actuating dogs. Fixed guide rod insures accurate alignment of dogs and switch contacts.

INSPECTION STATION
3 SWITCHES



• Depth is checked by means of switch actuating rod in hollow probe. If incorrectly seated, the MICRO SWITCH limit switch does not operate and dog operates return switch that also signals reject. This mechanism makes it impossible for empty tubes to be passed should paper supply become exhausted.

A complete line of snap-action and mercury switches



MICRO SWITCH provides a complete line of extremely reliable, small-size, high-capacity, snap-action precision switches and mercury switches. Available in a wide variety of sizes, shapes, weights, actuators and electrical characteristics. For all types of electrical controls.

MICRO SWITCH

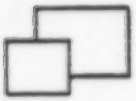
A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

In Canada, Lasalle, Toronto 17, Ontario • FREEPORT, ILLINOIS

FASTENS
ANYTHING
ANYWHERE

TAKE ONE ROUND HOLE

ANY SIZE IN THIN OR SOFT

MATERIALS  ANY TYPE.

PUSH IN THE NEW, THREADED INSERT OR

TAPPED-HOLE OF BANC-LOK

DESIGN WITH BOLT TO FIT.

LOCKS AUTOMATICALLY.

And there you have the ideal, low-cost method (Banc-Lok, of course) of blind fastening to sheet metals, plastics, or wood.

Banc-Lok is a new, exclusive development by Boots . . . leading manufacturers of self-locking nuts for aircraft.

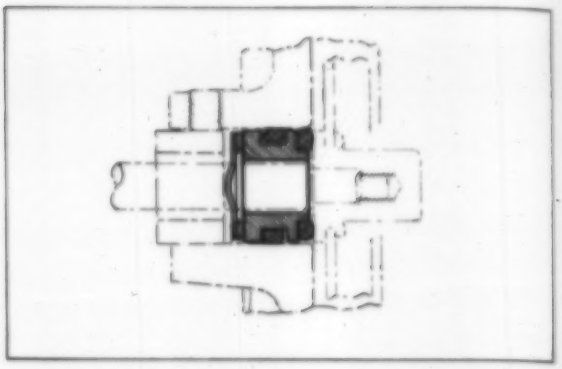
BANC-LOK
by BOOTS

BOOTS Aircraft NUT corporation
BANC-LOK DIVISION
536 NEWTOWN TURNPIKE • NORWALK, CONNECTICUT

Noteworthy Patents

(Continued from Page 301)

diameter than the recess forming the hub, it remains compressed between the seal body and both the inner diameter and mating seal face of the housing. Made



of flexible rubber-like material, the O-ring is relatively impervious to the working fluid. A modification of the invention seats the O-ring in an annular groove in the end face of the seal body. *Patent 2,691,542 assigned to Eastern Industries Inc. by H. G. Chenoweth.*

Nonjamming Ball Bearing Screw

Addition of a guided retaining cage between the worm and nut of a ball-bearing screw assembly prevents jamming by relieving the balls of any guiding function. A helical slot in the cage engages a guiding pin fixed to the nut. Flanges on the worm also guide the cage. In operation, both the nut and the worm directly and separately guide the cage to prevent wedging or jamming. *Patent 2,690,683 assigned to Roller Gear Co. Inc. by H. Schottler.*

Antifriction Bearing Seal

Flexible rubber-coated rings are utilized to provide lubricant retention over long periods of time in a seal designed for use on roller-bearing assemblies. Cup-shaped metal stampings form the outside of the seal assembly while a retaining ring fitted into the inside of the cup holds the flexible rubber ring in place. Mounted at both ends of the bearing, the seals act to lock the complete bearing assembly together. Additional lubricant may be added with a hypodermic needle if necessary. *Patent 2,690,362 assigned to Jeffrey Mfg. Co. by A. J. Kindig.*

New Machines

Materials Handling

Parts Feeder: Rotary hopper type feeder feeds presses, grinders, various other machines and machine tools. It can also be used for sorting, counting and inspection operations. Bowl-shaped feeder has a rotating wheel with radial slots which pick up parts and continually feed them through a trough. Angle at which parts are fed is adjustable. Feeder is powered by a fully enclosed, continuous-duty motor and has an adjustable slip clutch for overloads. The hopper can be supplied with up to four separate feeding tracks. *Feedmatic Inc., Detroit, Mich.*

Two-Platform Truck: Hydraulic-electric truck has two independently operating platforms which can be separated to a maximum vertical distance of 62 in. Each platform has a 2000-lb load capacity. The upper platform fits over the lower one in its lowered position. Upper platform measures 69 x 24 in.; lower platform, 53 x 21½ in. Upper platform provides a free lift of 35 in. with a maximum of 69 in.; lower platform can lift a load 4½ in. Overall height of the truck is 60 in. *Yale & Towne Mfg. Co., Yale Materials Handling Div., Philadelphia, Pa.*

Metalworking

Boring Machine: Model R-2 Super-Precision boring machine, combining electrical control with mechanical-rotary operation, is a multiple-spindle, single-end machine with 9-in. table stroke. It provides infinitely variable feed and traverse rates. The automatic operating cycle can include a timed loading period. Rotating elements which comprise the table-actuating mechanism assure long operating life and easy maintenance. The electrical control system is incorporated in a separate cabinet. Table and bridge are set at a 45-deg angle to permit rapid loading and unloading and free flow of coolant and chips. *Pope Machinery Corp., Haverhill, Mass.*

Press Brake: Optimum stroke length can be preset on the Di-Acro Hydra-Power press brake, and the ram can be stopped or reversed at any desired point in a work operation. Power is applied to a rotary hydraulic cylinder which is mechanically linked to the camshaft. Oscillating action of this cylinder has a maximum movement of 270 deg. Maximum power or pressure is obtained by working off the bottom of the stroke. The camshaft does not go through a complete cycle each time the clutch is tripped; one bending cycle is completed in the forward movement of the hydraulic cylinder and another in the return movement of the cylinder. Production rate of 24 strokes per minute can be maintained at the maximum 1½-in. stroke. Higher rate is possible with

(*Continued on Page* 310)

BRISTOL SCREWS SHOWN are 2½ times actual size.

Miniature Socket Screws Down to No. 0 for Every Application

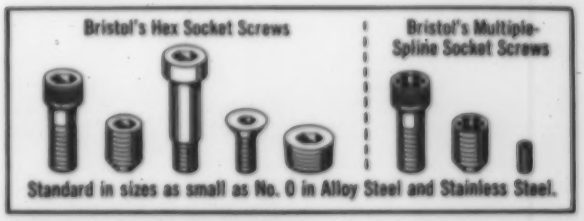
These Tiny Socket Screws are Standard with Bristol in sizes from No. 0 and up in Bristol's Hex and Multiple-Spline Socket Set and Cap Screws – in alloy and stainless steel.

We have been specializing in small-size socket screws for many years and have been making them by the millions in sizes down to No. 0 since 1930.

Gear-like teeth in Bristol's Multiple-Spline Socket enable the wrench to actually *pull* the screw around. *All* wrenching force is transmitted into rotary power. As a result these tiny screws can be wrenched tighter . . . to hold tighter.

Designed to fit right in with today's automation techniques, millions of Bristol's Multiple-Spline Socket Screws are used every year by leading makers of computers, instruments, guided missiles, razors, cameras and other precision products.

Ask your industrial distributor for Bristol's Multiple-Spline Socket Screws today. He's got them in sizes down to No. 0 wire. A.S.4



Standard in sizes as small as No. 0 in Alloy Steel and Stainless Steel.

BRISTOL'S SOCKET SCREWS

THE BRISTOL COMPANY

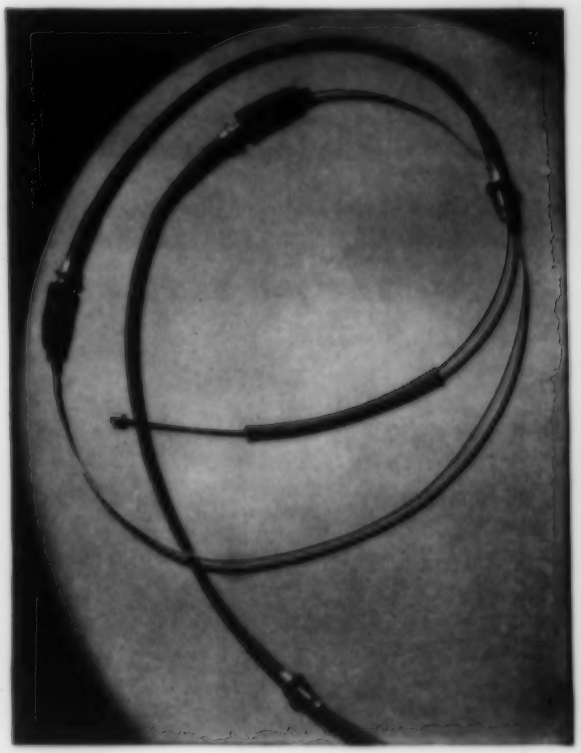
Can you guess what these American

A _____

Quality Springs are used for?

B _____

C _____



ANSWERS

A **CAR-PROOF.** You're looking at the wall of a striking new parking garage just erected in Chicago. American Steel & Wire furnished miles of stainless steel strand that runs continuously from the roof to the ground—where it is stretched tight by means of American Quality Springs. Appearance is breathtaking, and the novel construction prevents cars from rolling off the concrete slabs.

B **ONE LUNG GRAIN BIN.** When grain is stored, it *must* be adequately ventilated. American Steel & Wire produced thousands of these enormous steel "springs" that can withstand tremendous radial loads. In fact, they are laid on the floor of the bin, wrapped with AS&W Insect Screen, then covered with tons of wheat. Air can then be pumped through the tube, and the wheat stays dry and in good condition.

C **YOU USE IT ALMOST EVERY DAY.** It's not a terrifying medical instrument. Rather, this collection of cable, springs, clips and rubber boots is the entire parking brake assembly for a famous automobile. This entire unit was produced by American Steel & Wire.

●Remember, American Steel & Wire can supply *completely fabricated* wire and spring assemblies in quantity. Get in touch with your AS&W salesman . . . take advantage of American Steel & Wire quality—and *price*.

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL, GENERAL OFFICES: CLEVELAND, OHIO
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UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

USS AMERICAN QUALITY SPRINGS

UNITED STATES STEEL

ELECTRICAL
CONTACTS
ADJUSTING SCREWS
NOTE: LEFT-HAND THREADS
SPECIAL
SHAPES
ELCO
COLD-HEADED PRODUCTS
One interesting feature of several of the items above is that they are roll-threaded on the short end — a neat trick that called out some ingenuity on the part of ELCO shop people. ELCO facilities also include an Engineering Service that will help you design — or re-design — your special screws and similar pieces for lowest-cost manufacture. Always consult your ELCO representative.
COMPLETE LINE OF ELCO PRODUCTS
WOOD SCREWS
MACHINE SCREWS
MACHINE SCREW NUTS
TAPPING SCREWS
SPECIAL SCREWS
THREAD-CUTTING SCREWS
PHILLIPS AND SEMS SCREWS
COLD HEADED PRODUCTS
PIPE PLUGS
STOVE BOLTS
CAP SCREWS
LAG SCREWS
DRIVE SCREWS
"ELCO SCREWS ARE GOOD SCREWS . . .
ASK A MAN WHO HAS USED THEM"
ELCO TOOL AND SCREW CORPORATION
1950 BROADWAY, ROCKFORD, ILLINOIS

New Machines

(Continued from Page 307)

shorter stroke. Machine develops 12 tons pressure. Length of bed and ram is 36 in. *O'Neil-Irwin Mfg. Co., Lake City, Minn.*

Drilling Machine: Hole Locator drilling machine locates and drills holes without the need of jigs or fixtures and does not require laying out individual workpieces. It performs all standard drilling operations. A movable worktable can travel either forward and backward, sideways, or with combined motion. Movement range is 10 in. front to back and 15 in. side to side. Working surface of the table is 14 x 28 in. An optical viewer is mounted over a layout chart holder at the center of the forward edge of the table. Layout charts are thin sheet metal plates treated for scribing. Holes are located by moving the table to bring the scribed lines on the chart betwen cross hairs in the viewer. After the first hole is drilled the table is adjusted for subsequent holes. Work involving one or more previously cast or bored holes is positioned by using a cone center in the spindle. *Leland-Gifford Co., Worcester, Mass.*

Pneumatic Press: P66 series Vi-Speed air press has a 6 x 6-in. platen which is guided by a 5-in. piston rod and powered by a 5-in. cylinder with either 3 or 6-in. stroke. Close tolerances are maintained on all pieces, including those held off-center. Machine is available with either single or double power, providing 1900 or 3800 lb thrust at 100 psi. Working pressures range from 15 to 150 psi. An air return is available if heavy fixtures are to be attached to the moving platen. With base plates removed, the machine can be used as a press or vise for drilling, tapping and milling. *Van Products Co., Erie, Pa.*

Processing

Roller Coater: Designed to coat both sides of sheet metal, a new roller coater employs mechanical drives which permit removal of the rolls for cleaning without removing, restringing or resetting the drives. Upper and lower roll assemblies are completely independent; either can be removed or replaced without affecting other adjustments of the machine. Provisions are made for heating the rolls. Minute adjustments to the correct gage thickness and coating thickness are made with vernier controls. *Murray-Way Corp., Birmingham, Mich.*

Shell Machine: Bio-Core model W-1520 can produce both shell molds and shell cores separately or simultaneously. It utilizes the principle of low-pressure blowing of resin-coated sands into heated core boxes to produce shell cores. Shell molds can also be made by blowing into heated patterns or die cavities. Curing begins immediately, and cores or molds are ready for use in 20 or 30 seconds. Machine does not employ drier plates or ovens. Blowing into heated pattern cavities produces contoured shell molds Cores can be made hollow. The two-station machine requires 24 sq ft of floor space and accommodates core boxes, or patterns, up to 15 x 20 x 36 in. high. It is adaptable to either horizontal or vertical partings. *C & S Products Co., Detroit, Mich.*

Ross poppet valves

you'll see on equipment at the Chicago Shows

Speed Control Valve

Foot Operated

Solenoid Introld (Pilot Operated)

Retrold (Remote Controlled) MV, Pressure Operated

Double Solenoid Direct Operated

Solenoid Introld (Pilot Operated)

Hand Operated

Solenoid Direct Operated

Retrold (Remote Controlled) TD, Sequence Type

Pilot Valve

Solenoid Introld (Pilot Operated) Momentary Contact

Hand Operated

Solenoid Introld (Pilot Operated) Safety

Gas Direct Operated

- *Dependable, positive action*
- *Prevent leakage*
- *Simple installation*
- *Sturdily built*
- *Instant, lightning-like control*

NEW! Important, timely and interesting articles on pneumatics with engineering facts and diagrams. Ask your Ross representative for the August issue of the new "Ross engin*air*," or write direct.

Tomorrow's Engin*AIR*ing Delivered Today . . . *Anywhere*

Control

Ross OPERATING VALVE COMPANY

109 E. GOLDEN GATE AVENUE • DETROIT 3 • MICHIGAN

SPECIFY SIRVENE

There are lots of reasons why so many leading machine tool builders agree on Sirvene wipers. You'll find them tops in design, quality and service.

Sirvene wipers are molded as precisely as the setting on a lathe. They must be . . . to exclude fine abrasives and chips, water emulsions or other corrosive materials from bearings. Another reason is their broad resistance to oils, chemicals, solvents, temperatures, abrasion and wear. New metal face and metal cased wipers furnished 22″ long with smudge-free, grey synthetic rubber.

Whether you require wipers of standard or special designs for critical service, investigate Sirvene. You'll find the unmatched experience of C/R Sirvene engineers of great help in meeting your specifications.

GET the basic information on this versatile material. "Engineering with Sirvene" will be sent on request at no charge.

C/R SIRVENE
SCIENTIFICALLY COMPOUNDED ELASTOMERS

CHICAGO RAWHIDE MANUFACTURING COMPANY

1301 Elston Avenue SIRVENE DIVISION Chicago 22, Illinois

Other C/R products

OIL SEALS: Shaft and end face seals for all types of lubricant retention and dirt exclusion • CONPOR: Controlled porosity mechanical leather packings and other sealing products • SIRVIS: Mechanical leather boots, gaskets, packings and related products.

Now...Rubber Fingers Buff Metal Parts with "Mud"!

THIS IS A liquid burnishing machine. In it, metal parts receive their proper, pre-plating finish by being scrubbed with an abrasive "mud."

Biggest advantage of the "mud machine" is its elimination of dust and lint with their threat of silicosis. It also removes the danger of fire, lowers scrap and permits higher production per square foot – all at lower cost!

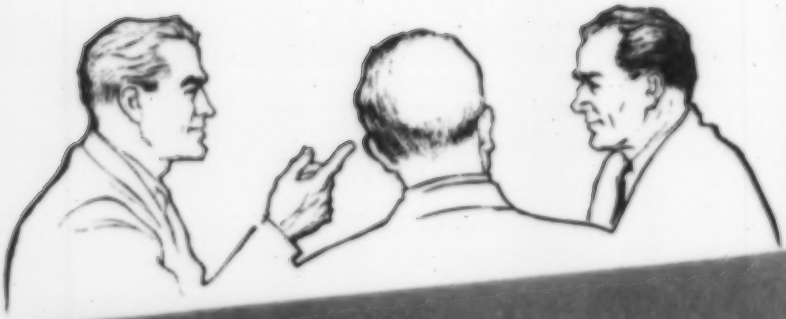
The scrubbing of the parts is accomplished with a series of rubber mats, each having hundreds of fingers. And therein lay a problem for the designers. The extreme abrasion, severe flexing of the fingers and constant use in water quickly took their toll of mats made with ordinary rubber. Finally, the G.T.M. – Goodyear Technical Man – was called on for help.

The G.T.M. came up with a special compound for the job plus changes in design which resulted in a much more durable mat and commercial feasibility for the machine. How can you use his experience and expert knowledge of rubber? Any molded goods problem will find a better answer at Goodyear, Industrial Products Division, St. Marys, Ohio or Akron 16, Ohio.

MOLDED GOODS by

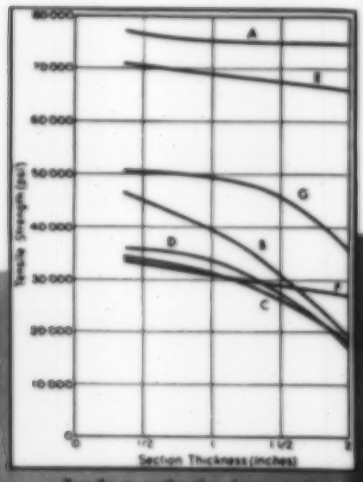
GOODYEAR

THE GREATEST NAME IN RUBBER

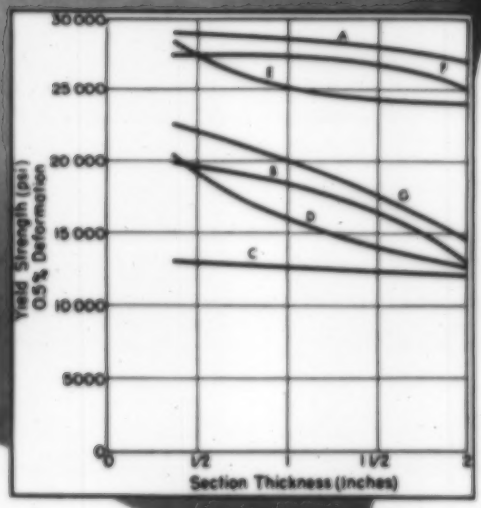


Here's proof....

that you can use lighter sections, have greater strength, improve your product, save money with AMPCO* Metal



Tensile strengths of various non-ferrous metals vs. section thickness



non-
thickness

Examine these charts carefully — they tell a story that can save you money and put extra life and dependability into your product.

Look, for instance, how other non-ferrous metals show a sharp decrease in mechanical values as casting cross-sections increase. Ampco remains practically constant — you require less metal.

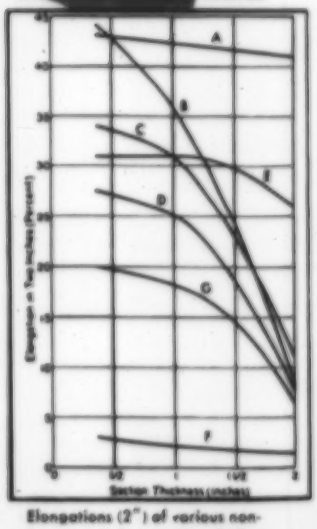
Note Ampco's unusually high tensile and yield strengths compared with conventional bronzes — you use lighter sections to do a better job. And Ampco Metal weighs 10 to 15 percent less than other bronzes — so you can make important weight reductions.

Fact is, Ampco Metal's high strength-to-weight ratios can mean real savings for you — savings in material and money. Consult your nearby Ampco field engineer for full information or write us.

CHART REFERENCE

- A. Ampco Metal
- B. Tin Bronze (88-8-4)
- C. Red Brass
- D. Tin Bronze (85-5-5-5)
- E. Manganese Bronze
- F. Aluminum Alloy
- G. Silicon Bronze

Charts courtesy Materials & Methods and Westinghouse Electric Corp



Elongations (2") of various non-ferrous metals vs. section thickness

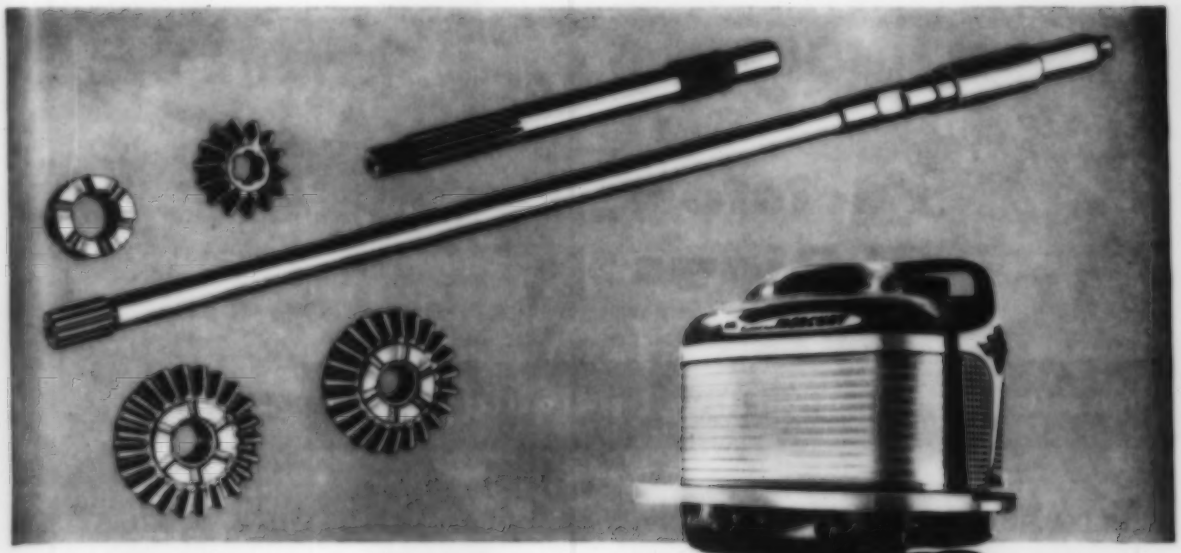
AMPCO METAL, INC.

Sole Producer of Genuine Ampco Metal

Dept. MD-8, Milwaukee 46, Wisconsin
West Coast Plant: BURBANK, CALIFORNIA

*Reg U S Pat Off

8-45



G.S. SMALL GEARING

CONTRIBUTES TO THE TOP PERFORMANCE OF

KIEKHAEFER **MERCURY**

OUTBOARD MOTORS

Mass-producing *consistently better* Small Gearing for fine outboard motors has been a specialty of ours for years. Quality-minded manufacturers, like THE KIEKHAEFER CORPORATION, makers of MERCURY Outboards, have learned from long experience to depend upon us for the high degree of uniform accuracy needed in gears designed to transmit the surging power of these modern high-speed engines. Size for size, the G.S. Gears in the famous Mercury Quicksilver lower units are subjected to greater sustained high-speed and impact loads than in any other known application.

Close inspection of G.S. Gearing soon shows its burr-free *smoothness* . . its strict conformity with exacting specifications. These and other fine features are indicative of the superb machining that assures long, service-free performance for our customer's products.

If top quality Small Gearing, from 8 to 96 dp is an important consideration in *your* business, by all means make use of our years of specialization in this field! See for yourself why superior G.S. craftsmanship is successfully serving so many critical manufacturers from coast-to-coast

GET OUR *Free* 6-PAGE FOLDER

See where and how we mass-manufacture Small Gearing to uniformly fine tolerances. This attractive 8½ x 11" 6-page folder is punched for ring-binder use. It contains 23 pictures of Small Gears, plant views, as well as Diametral and Circular Pitch Tables. Ask for your copy on company stationery, please!

40 Years of Specializing in Small Gearing!

GEAR Specialties, Inc.

Spurs · Spirals · Helicals · Bevels · Internals · Worm Gearing · Racks · Thread Grinding

2635 WEST MEDILL AVENUE · CHICAGO 47, ILLINOIS

MEMBER OF

WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARS

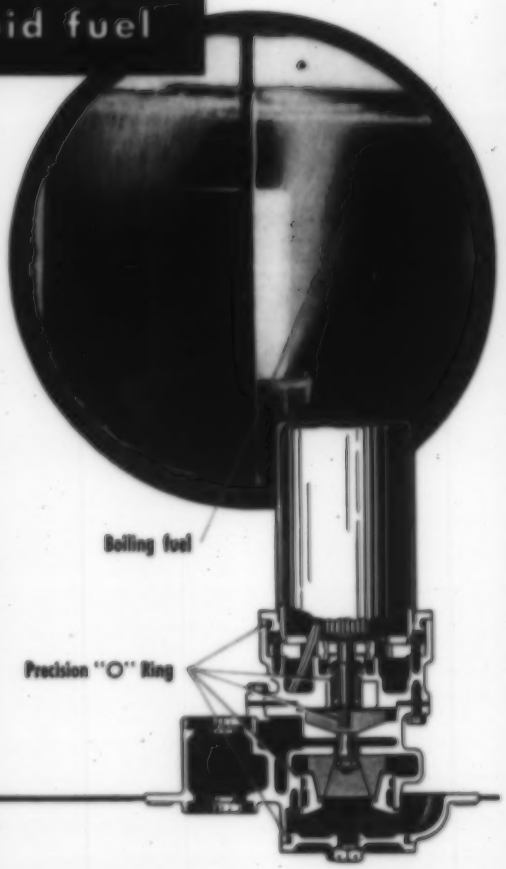
Precision "O" Rings

insure constant flow of liquid fuel

To provide positive and constant fuel flow, Lear-Romec centrifugal booster pumps are used in many high altitude aircraft. They are submerged directly in the fuel tank where they separate the fluid from the troublesome vapors which are formed at higher altitudes.

Lear-Romec engineers, who developed these amazing pumps, selected PRECISION "O" Rings for the tough job of sealing the booster pump from these destructive fuel vapors. Now, thanks to PRECISION quality, fuel vapors cannot interrupt operation and "kill" the engine.

Tough compression-molded PRECISION "O" Rings are the finest ever made. They are universally used for the toughest vapor and liquid sealing jobs in hydraulic mechanisms, control valves, couplings and hundreds of other assemblies. Why not put PRECISION in your plans?



FREE — Write for your personal copy of our Handbook on "O" Rings

Precision Rubber Products CORPORATION

"O" Ring and Dyna-seal Specialists

Box 431 Oakridge Drive, Dayton 7, Ohio Canadian Plant at: Ste. Thérèse de Blainville, Québec

Further Information?

If you would like further information on any of the ADVERTISEMENTS in this issue, circle the page numbers of these items on one of the cards below. Then fill in your name and address and mail to us. Your requests will be forwarded to the companies concerned, the answers coming direct to you. When more than one advertisement appears on a page, the following code will be used for identification: T—Top, B—Bottom, L—Left, R—Right (IFC—Inside Front Cover. IBC—Inside Back Cover. OBC—Outside Back Cover)

- For extra copies of editorial articles use EDITORIAL REQUEST CARDS—Page 198
- For further information on New Parts and Equipment, Engineering Department Equipment, and Helpful Literature, use HELPFUL LITERATURE REQUEST CARDS—p.215

AUGUST 1958

IFC	T44	78	113	228	266	BR298	BL331
1	B44	79	114	229	267	299	R331
2	45	80	115	232	268	300	L332
5	46-47	81	116	233	269	301	TR332
6	48	82	117	234	270	302-3	BR332
8	49	83	118-9	235	271	304	TL333
9	50	84-5	120	236	272	305	BL333
11	51	86	121	237	273	306	R333
13	52	87	122	238-9	274-5	307	T334
15	53	88	123	240	276-7	308-9	BL334
17	54	89	124	241	278	310	BR334
19	55	90	125	242	279	311	TL335
20	56	91	126	243	280	312	BL335
22-23	57	92	127	244	281	313	R335
25	58	93	128	245	282	314	L336
T26	59	94	129	246	283	315	TR336
B26	60-61	95	130	247	284	316	BR336
27	62	96	131	248	T285	317	TL337
28	63	97	132	249	B 285	318	BL337
29	64	98	133	250	286-7	320	R337
L30	65	99	134	251	288	321	TL338
R30	66	100	209	252-3	289	322	TR339
31	67	101	211	254	T290	323	BL339
32	68	102	213	255	B290	324	BR339
35	69	103	214	256	291	325	L340
36	70	104	217	257	T292	326	TR340
37	71	105	219	258	B292	328	BR340
T38	72	106	221	259	293	329	342
B38	73	107	223	260	294	L330	343
39	74	108-9	224	261	L295	TR330	344
40-41	75	110	225	262	R295	BR330	IBC
42	76	111	226	263	296-7	TL331	OBC
43	77	112	227	264-5	L298		

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Cleveland 13, Ohio

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FIRST CLASS
Permit No. 36
(Sec. 34.9 P.L.&R.)
Cleveland, Ohio

BUFFALO AND ERIE COUNTY PUBLIC LIBRARY

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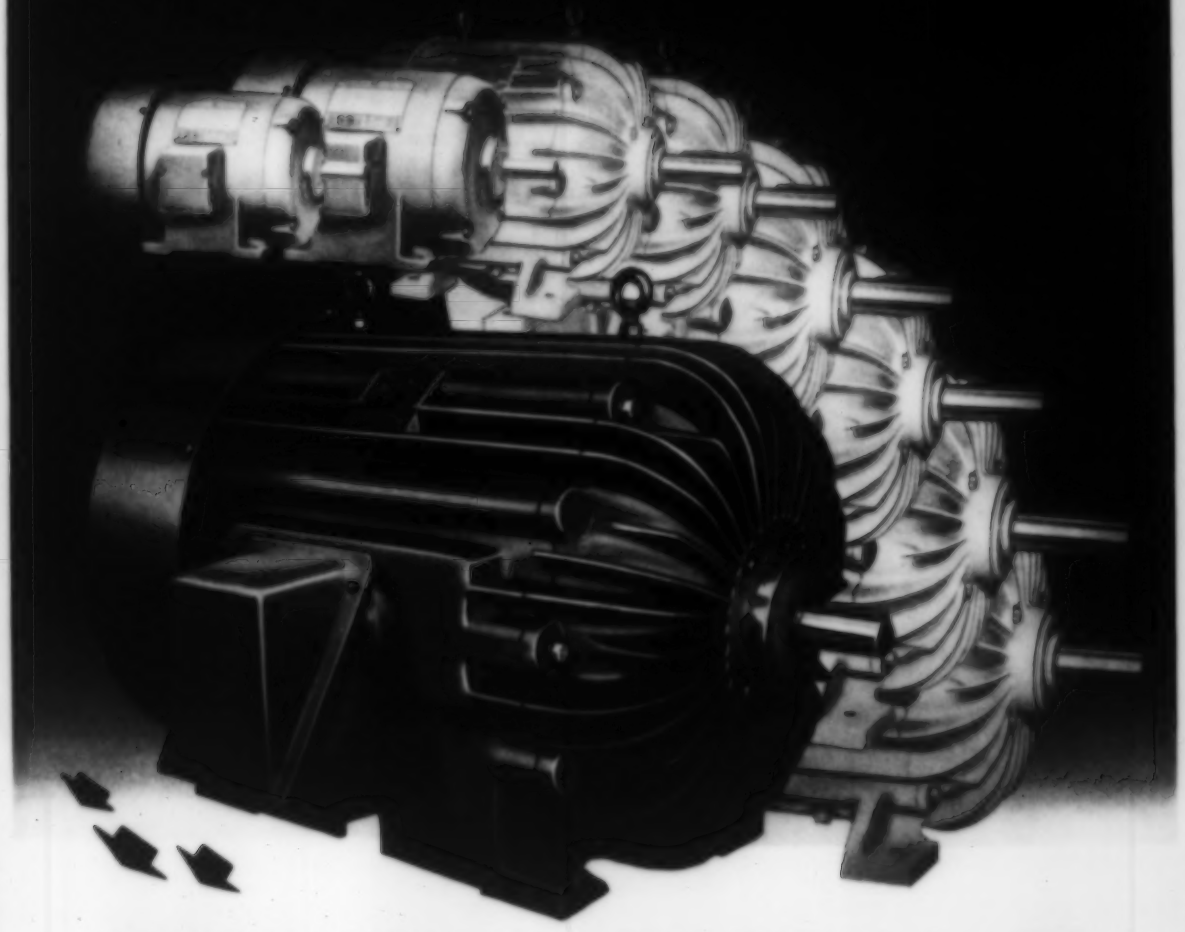
MACHINE DESIGN
Penton Building
Cleveland 13, Ohio

FIRST CLASS
Permit No. 36
(Sec. 34.9 P.L.&R.)
Cleveland, Ohio

Reader's Service Dept.

TOTALLY ENCLOSED MOTORS



COMPLETE RANGE IN FRAME SIZES 56 thru 680

For the Whole Story
Write for ME Bulletin No. 158

Totally Enclosed Non-Ventilated
Totally Enclosed Fan Cooled
Totally Enclosed Forced Ventilated
UL Listed Explosion Proof

MARATHON ELECTRIC DESIGNS AND MANUFACTURES
MOTORS - $\frac{1}{20}$ - TO - 2500 HP • GENERATORS - $\frac{1}{2}$ - TO - 2000 KW

SINCE 1913

MARATHON ELECTRIC

HOME OFFICE AND FACTORY, WAUSAU, WIS. FACTORIES AT ERIE, PA. AND EARLVILLE, ILL.

SALES OFFICES IN PRINCIPAL CITIES

MOTOR FACTS ON INDUSTRY'S
MOST PREFERRED "POWER PACKAGE"

Electrical System Fact—Only the new Life-Line "A" motor gives you the unsurpassed corrosion-resistant protection of exclusive new Bondar, Bondite and Mylar* insulations.

*Du Pont Registered Trade-Mark

FACT:

The new Life-Line "A" is the most corrosion-resistant motor on the market

The corrosive action of chemicals takes a heavy toll on conventional motors. The new Westinghouse Life-Line® "A" motor offers more protection against corrosive atmospheres than any other motor you can buy. How?

Because the combined improvements in insulation, housing and bearing design give unsurpassed protection against any contamination. It takes the right combination of such improvements in *all three systems*—electrical, mechanical and lubrication—to make the Life-Line "A" industry's most preferred power package.

Get all the facts by calling your Westinghouse sales engineer . . . *The Man With The Facts.*

J-21881

YOU CAN BE SURE . . . IF IT'S

Westinghouse

Mechanical System Fact—New cast-iron frames and brackets utilize the finest grained castings with uniformly thick wall sections precisely fitted and sealed. Molded glass plastic cooling fans on totally-enclosed types are chemically inert.

Lubrication System Fact—The new pre-lubricated Life-Line "A" bearing features a "4-way seal"—*two* seals on each side. Totally-enclosed types have additional neoprene flinger which assures bearing protection in any corrosive application.

need quick service on TIMERS for automatic control?

Time Delay Timers

The more automatic control problems we get, the better we like it. For while it's true each automatic control job is a bit different from the rest, the record shows that our 19 years of timer experience has given us the special knowledge it takes to give you the right answers, and in near-record time.

If one of our standard timers won't do your job — or one of the 721 combinations we have thus far developed from our 17 basic units — our engineers will go right to work to develop a new combination that's the one for you. That's the way we grow — and we like it.

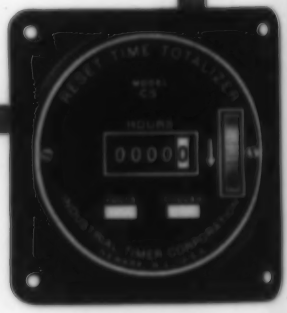
We manufacture a complete line of timers in these 4 broad classifications:

TIME DELAY TIMERS • INTERVAL TIMERS
RE-CYCLING TIMERS • RUNNING TIME METERS

And since we maintain large stocks of our 17 basic units, we can assure you of rapid deliveries — of excellent deliveries even on special orders. So whatever your automatic control problem, you have everything to gain by submitting it to our timer specialists. They'll give you a profitable answer — almost with the speed of automatic control itself.

Interval Timers

Re-Cycling Timers

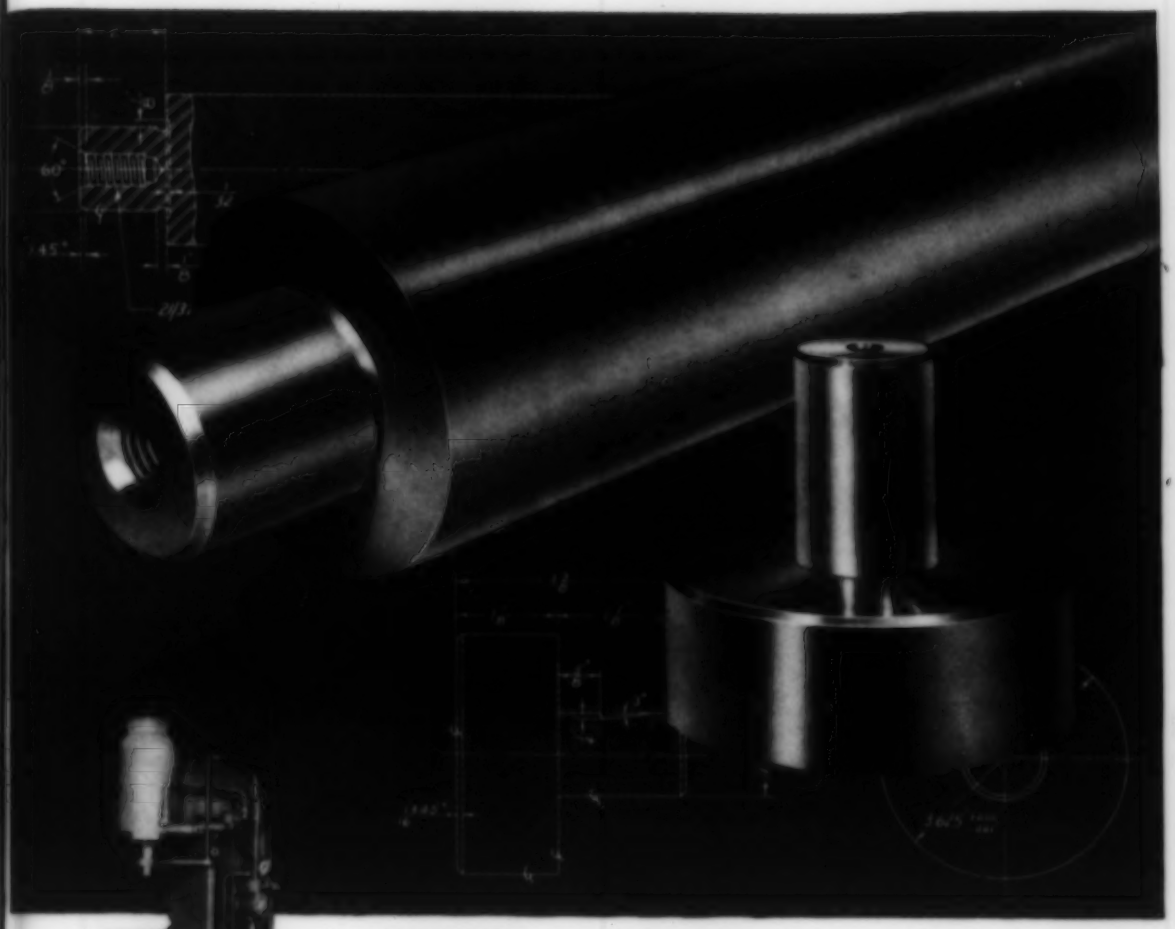


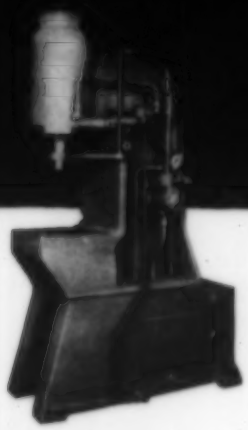
Running Time Meters

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

131 OGDEN STREET, NEWARK 4, N. J.





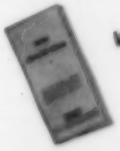
MAX-EL Alloy Steel means no distortion—longer wear in 15-ton hydraulic press ram

To keep this 15-ton press operating day after day for years of dependable service, takes *special* steels. For example, even after thousands of cycles of operation, the ram *must* remain accurately in line with the work table. *It demands a steel that will not distort, set or wear.*

That's why both the ram and ram-plug are made of Crucible MAX-EL alloy steel. In fact, the manufacturer, Greenerd Arbor Press Co., Nashua, N. H., has been a steady user of MAX-EL for many years.

Here's what they have to say—*"We have tried many grades of steel, but we find that MAX-EL 3½ heat-treated in the bar works out better for our application."*

And it probably will for yours, too. So when you have a job calling for a non-deforming alloy steel—one with excellent machinability, high-strength and wear-resistance—try Crucible MAX-EL. It's promptly available from your nearby Crucible warehouse, in the sizes and grades you need. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*



Write for your free copy of this Crucible Publication Catalog listing dozens of helpful booklets and data sheets.

Visit us at Booths 830-832 Production Engineering Show, September 6-16, Navy Pier, Chicago.

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

Painting, courtesy Power Magazine

New J-M Color Code identifies metal in Spirotallic® Gaskets

Most engineers know that Spirotallic Gaskets maintain a perfect seal despite extreme fluctuation in fluid pressure and flange compression. Consequently, these gaskets are used in a wide range of service conditions which include high temperatures, elevated pressures and active corrosives. To withstand these conditions, Spirotallic Gaskets employ a variety of corrosion-resistant alloys.

Because so many of these metals look alike, only expensive tests or costly experience with the gasket could determine the gasket metal used, once its identifying tag was lost. Now the color patch on the centering guide tells the metal employed and saves time, trouble and expense. This new method of identification also makes it easier for storekeepers and mechanics who handle the gasket. In addition, it simplifies inventories.

Spirotallic Gaskets hold their seal because they are made of spirally wound interlocking plies of asbestos and spring-like metal strip. These gaskets compress easily with light bolting. For catalog PK-55A and copy of color code card write Johns-Manville, Box 60, New York 16, N. Y. In Canada, Port Credit, Ont.

Here are seven of the metals available and their color identifications

Zinc-coated steel—white

Type 304 Stainless—yellow

Type 316 Stainless—green

Type 347 Stainless—blue

Monel—orange

Copper—brown

Aluminum—aluminum

Johns-Manville SPIROTALLIC GASKETS

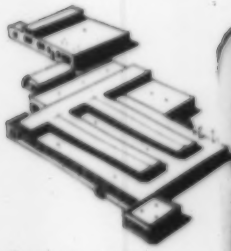
ANNOUNCEMENT!

Teer-Wickwire, manufacturer of precision parts, takes over Lindberg cylinder line

Now Lindberg Air and Hydraulic Division of Lindberg Engineering is Lindberg Air and Hydraulic Division of Teer-Wickwire & Co. Operations have been moved from Chicago to Jackson, Michigan, into a new plant devoted to cylinder manufacture.

Out of this modern 60,000 square foot plant at Jackson will come the present line of Lindberg air and hydraulic cylinders, manufactured to new standards of quality, durability and performance. In development now, and due for release soon, are revolutionary new cylinders to meet tomorrow's requirements with less bulk, less weight, less cost.

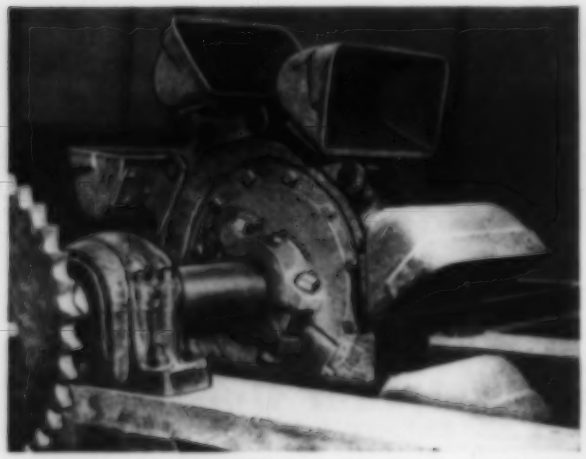
WHO IS TEER-WICKWIRE & CO.?



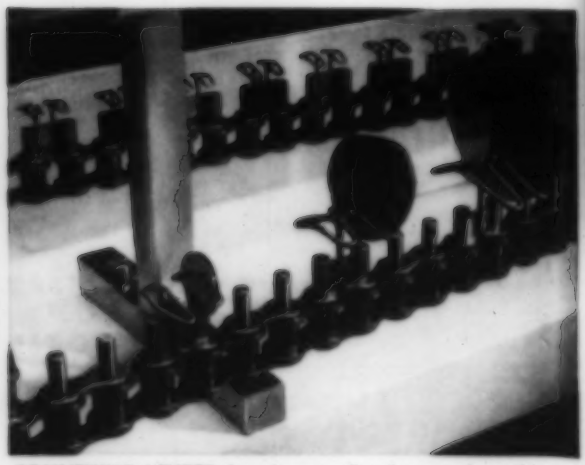
We are specialists in mass production of precision parts and components at low cost. We have been a contract manufacturer for the automotive industry for 25 years. We are *exclusive* suppliers of several components for some of the largest makers. Our plants are tooled with the latest machines. We combine proven production methods with rigid quality control systems to achieve high quality at competitive costs. *All of this experience now goes to work for users of air and hydraulic cylinders!*

The Monarch Tracer-type lathe pictured is typical of the modern machine tools used in our plant.

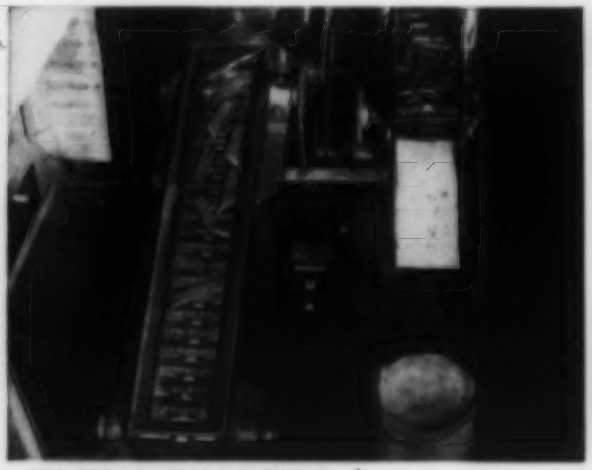
LINDBERG AIR AND HYDRAULIC DIVISION
TEER-WICKWIRE & COMPANY
Jackson, Michigan



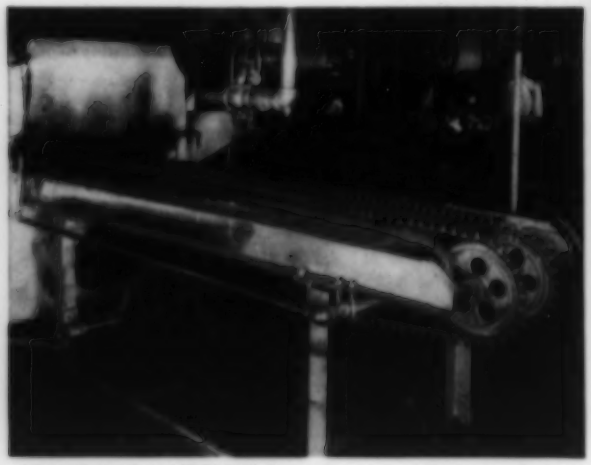
CUTTING MAINTENANCE for bucket elevators and heavy-duty conveyors took an imaginative solution by the CHAIN Belt Man and his engineering department. The answer...a segmental sprocket hub with a unique bolted-on rim that could be installed and replaced easily.



CONVEYING LENSES for glasses offered a tough problem. The CHAIN Belt Man solved it by the use of a roller chain with extended pins. Pins have removable clips which carry the lenses. The chain operates on its side and various size clips are interchangeable.



FOR ECONOMICAL HANDLING of hot cutting bits into and out of an oil tempering bath, the CHAIN Belt Man recommended a Rex Steel TableTop Chain. The rugged, smooth carrying surface of TableTop is ideal for handling small parts.



CONVEYING MATERIALS through an annealing oven isn't a tough problem, thanks to the complete chain line offered by CHAIN Belt. Heat and corrosion-resistant Rex® Stainless Steel Roller Chain with standard M-35 attachments provided a long-lasting, economical answer.

Help for the Imaginative Designer

To help you solve design problems of chain selection and application, your CHAIN Belt Man doesn't offer a trite solution. Rather, he applies a trained imagination to seek the best possible answer. For, in selecting and applying chains for drive or conveyors, the field is limited only by the experience and imagination of the designer.

Your CHAIN Belt Man has a complete line of chains, attachments and sprockets to draw upon...a broad background of experience and a home-office engineering staff to help him help you.

Where you need an unusual solution to a usual or unusual problem in cutting costs...improving machine performance...use the help offered by your CHAIN Belt Man. Call him or write CHAIN Belt Company, 4643 W. Greenfield Ave., Milwaukee 1, Wisconsin.

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DU PONT

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

NEWS

NO. 6 — 1955

How 3 Du Pont engineering materials helped solve a design problem...produce a better product

Du Pont engineering materials improve design! The "Magna Impella" on this drink dispenser uses three Du Pont engineering materials: "Alathon" polyethylene resin, "Teflon" tetrafluoroethylene resin, and "Lucite" acrylic resin.

Improved design eliminates stuffing box and mechanical linkage

THIS "Jet Spray Cooler" pictured at left has an interesting operating story—centered around the use of three Du Pont engineering materials. Unlike the usual drink dispenser, which needs a linkage to the motor to spray liquids inside the bowl, this dispenser circulates liquid by *magnetic action.*

Here's how it works

A permanent magnet is imbedded in an impeller of Du Pont "Alathon" that sits in a well on the bottom of the bowl. "Alathon" polyethylene resin is used because it's tough, absorbs very little moisture, can be molded around inserts, and resists corrosion. Directly below the impeller is a powerful, motor-driven horseshoe magnet. The motor turns the horseshoe magnet, which in turn spins the impeller. Liquids are forced up through a connecting tube of opaque Du Pont "Lucite" acrylic resin and out into the bowl.

Needs no oiling

The impeller shaft revolves on a bearing of Du Pont "Teflon" tetrafluoroethylene resin. This material has toughness combined with an extremely low coefficient of friction. It needs no oiling—eliminates any possibility of contamination. And topping the drink dispenser is a sparkling bowl of injection-molded "Lucite"—outstanding for its transparency and resistance to discoloration.

Here, then, is another example of how products and processes can be improved through an imaginative use of these Du Pont engineering materials. Can they help your operation? Use the coupon on the back of this page for further information. (Dispenser manufactured by Jet Spray Cooler, Inc., Boston, Massachusetts.)

OVER

Specular glare eliminated with diffusers of extruded Du Pont LUCITE® acrylic resin

WORKERS perform tasks with greatest accuracy, speed and comfort under well-designed lighting conditions. Lighting engineers have established that a brightness ratio of 9 at light source to 3 at task area and 1 at surround is the most comfortable lighting environment.

Diffusers of Du Pont "Lucite" acrylic resin effectively assist in achieving this ideal ratio. Extruded sheets and panels of this durable engineering material transmit optimum light while eliminating glare and minimizing shadows. The rated lumen output of properly maintained fixtures of translucent white "Lucite" remains essentially constant through years of service, while resisting discoloration and other aging characteristics.

Write for information on lightweight, shatter-resistant "Lucite".

DU PONT

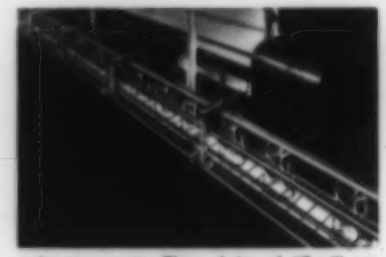
PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

NEWS

NO. 6 — 1955

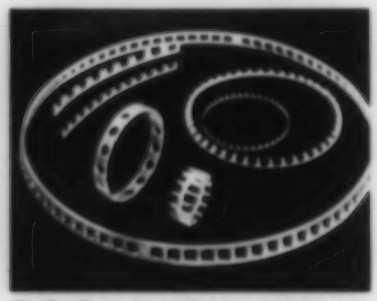
Properties of ZYTEL® nylon resin demonstrated with these new product applications

THESE typical applications of Du Pont "Zytel" nylon resin illustrate some of the properties which make this versatile material so useful to the design engineer. The properties of "Zytel", used singly or in combination, provide the opportunity to evaluate product improvement or new product development in terms of this Du Pont engineering material.



(1) Parts of "Zytel" resist abrasion Used for guide shoes which connect elevator cars to vertical guide rails and slide along the rails at speeds up to 1000 feet a minute, "Zytel" nylon resin exhibits remarkable abrasion resistance. "Zytel" gives much longer service than materials previously used, yet requires no lubrication. Guide shoe molded by Paragon Molding, Inc., Melrose Park, Illinois, for the Adams Manufacturing Company, Chicago, Illinois.

(2) Parts of "Zytel" often need no lubrication New conveyor chains made from links molded of "Zytel" nylon resin assure long service life and low maintenance costs. These chains of "Zytel" run smoothly without lubrication, saving the cost of lubricants. Power costs are cut, too. Tests show that the belts of "Zytel" carry, with 1/5 to 1/2 the chain pull, a load carried by comparable lubricated steel chains. Links molded by Du Bois Plastic Products, Inc., Buffalo, N. Y., for Fenco Inc., Chicago, Illinois.



(3) "Zytel" can be molded into intricate parts Design engineers specify "Zytel" nylon resin for a great variety of product designs where its ability to be molded into intricate shapes proves desirable. Single parts of "Zytel" often replace multi-part assemblies of other materials. The moldability of "Zytel" nylon resin is well illustrated by the seven samples of molded bearing cages shown above. Cages manufactured by the Kaydon Engineering Company, Muskegon, Mich.

(4) Parts of "Zytel" are tough Heat-treated metal facings were used on a continuous-operation clutch. The clutch revolves at 1750 R.P.M., transmits 75 ounce-inches of torque, undergoes up to 1440 engage-disengage cycles a day. The metal facings had to be replaced 17 times a year. Facings of tough, molded "Zytel" were installed. Replacement has been cut to 3 times a year. Clutch molded by the Danielson Manufacturing Company, Danielson, Conn., for Minnesota Mining and Manufacturing Company, St. Paul, Minn.

(5) High-temperature applications utilize "Zytel" This silverware basket molded of "Zytel" nylon resin, used in the 1955 General Electric dishwasher, withstands scalding temperatures without cracking or distortion. Baskets of "Zytel" can be handled promptly after leaving the dishwasher. These resilient baskets of Du Pont "Zytel" nylon resin will not break or dent if dropped. Basket molded by Plastics Division, General Electric Company, Decatur, Illinois.

(6) "Zytel" resists heat "Zytel" nylon resin is useful for many applications where heat resistance is important. Because of its ability to withstand use at temperatures up to 250°F., together with its toughness and resistance to abrasion, "Zytel" is used for aircraft cable clamps, strain-relief clamp blocks, grommets, wire guides and support blocks, terminal blocks, and like parts. "Zytel" nylon resin is useful, too, as cable jacketing, because of its resistance to heat and gasoline.

Investigate Du Pont engineering materials in your product development programs

ONE of the family of these versatile engineering materials is often a key factor in product improvement or new design. The wide range of properties available with "Alathon"* polyethylene resin, "Lucite"* acrylic resin, "Teflon"* tetrafluoroethylene resin, and "Zytel"* nylon resin are helping solve industrial design problems.

CLIP THE COUPON for additional data on the properties and applications of these Du Pont engineering materials.

E. I. DU PONT DE NEMOURS & CO. (Inc.) POLYCHEMICALS DEPARTMENT
Room 138, Du Pont Building, Wilmington 98, Delaware.
In Canada: Du Pont Company of Canada, Ltd., P. O. Box 660, Montreal, Quebec.

Please send me more information on the Du Pont engineering materials checked: ☐ *"Zytel"*; ☐ *"Alathon"*; ☐ *"Teflon"*; ☐ *"Lucite". I am interested in evaluating these materials for:*

NAME _____ POSITION _____

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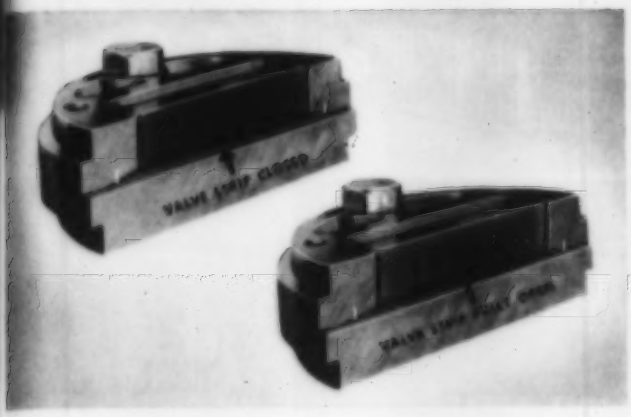
*"Alathon", "Lucite", "Teflon", and "Zytel" are registered trade-marks of E. I. du Pont de Nemours & Co. (Inc.)

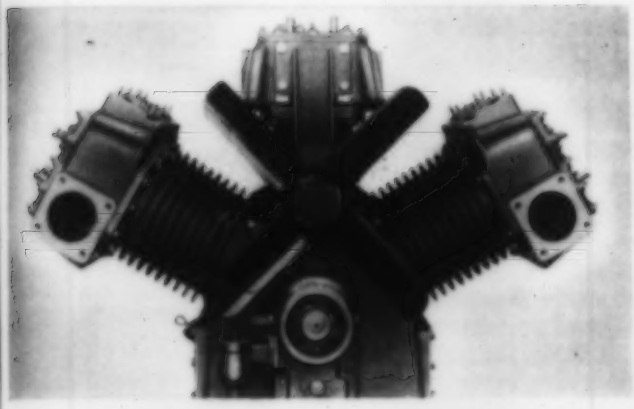
WHAT'S YOUR C.Q.*?

*COMPRESSOR QUOTIENT



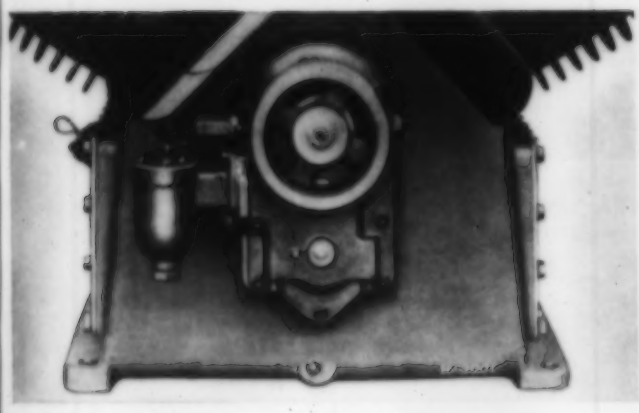
What's the lightest-acting air compressor valve made?

No doubt about this one — it's Worthington's exclusive Feather* Valve. Responsive as a feather to air flow, it can open, release air and close in one-hundredth of a second—with no back-leaking and efficiency losses. You can get more information about the Feather Valve by writing for Bulletin L-675 S12.



How can you get effective air cooling of air compressors?

Fan-cooling of isolated cylinders is the answer. In Worthington Radial and Balanced Angle air compressors, cooling air flows completely around the isolated cylinders. And the high-capacity fan blows air directly over upper parts of cylinders and cylinder heads — where heat is greatest. Our Bulletin H-630-B1 tells you more about Worthington Radial air-cooled air compressors.



What's the modern way to lubricate an air compressor?

The right answer is force-feed lubrication—with continuous full-flow oil filtration. And that's exactly what you get in Worthington Radial Air Compressors (and *only* Worthington, by the way). Result: less bearing wear, less oil pumping, longer cylinder life and lower lubricating oil cost. One twist of the handle cleans the Cuno filter without stopping flow. Read Bulletin H-630-B1 for more facts.

PC.5.3

Reg. U.S. Pat. Off.

Write today for bulletins to Worthington Corporation, Section PC.5.3, Harrison, N.J.

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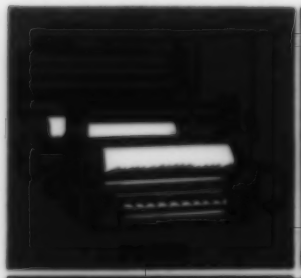
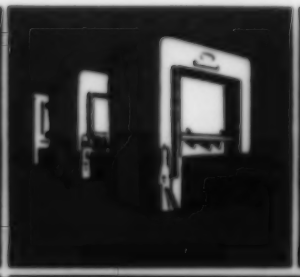

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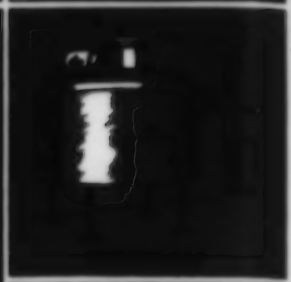
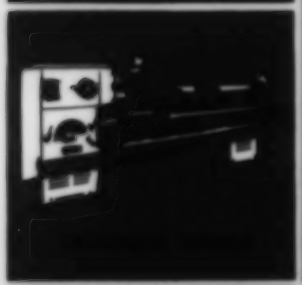
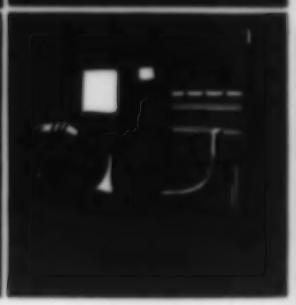
Send for our new Bulletin GB2, describing and illustrating the basic Dynamatic Eddy-Current units.







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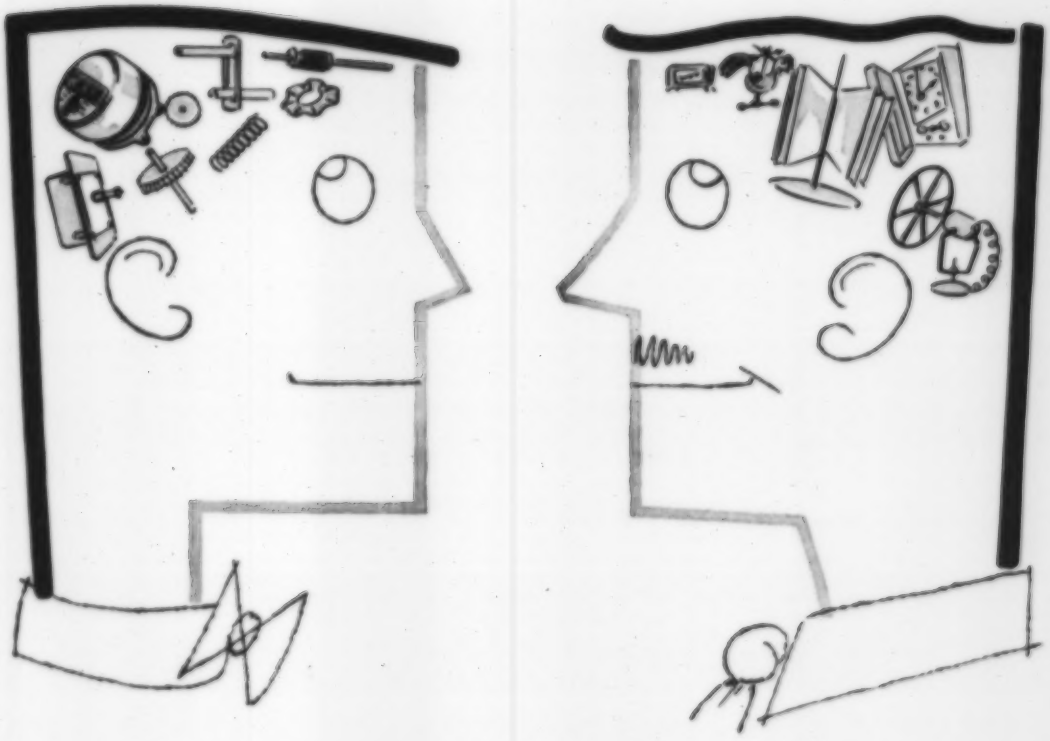

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Do this . . . and let our engineers submit their suggestions along with a sample motor. We may save you many costly manhours of research and test time. This service is free to any established organization of sound reputation and reliable rating. We suggest you contact your local SYNCHRON Representative, or address the factory. All development engineering is conducted in strictest confidence.

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Low-cost, easy-to-form "Beryldur" makes expander spring that requires no adjustment

This finger spring is a U packing expander which maintains a seal at 0-5 pounds in the cylinder of a hoist.* What are the characteristics demanded in an application of this kind? First, corrosion resistance. "Beryldur," like all beryllium copper alloys, is highly corrosion resistant. Second, uniform spring pressure. If the expander is too loose, the packing will leak oil and water. If it is too tight, it will prevent the plunger from moving freely. It is enough to say on this point that this "Beryldur" expander never needs field adjustment.

Finally, formability is all-important. The 130° bends parallel to the rolling direction around a 1/16" radius could cause trouble—but in "Beryldur," grain direction is uniform and blanking is no problem. The expander was originally made of 12 6-in. sections riveted together; now it is made of two strips of mill-hardened "Beryldur."

The properties of "Beryldur" are midway between those of high-strength and high-conductivity "Berylco" Beryllium Copper alloys. "Beryldur" therefore has a higher tensile strength than brass or bronze, plus high fatigue strength, great resistance to wear, and good electrical conductivity. For sample material or engineering help, call or write any of the offices listed below.

*Made by Globe Hoist Co., Des Moines, Iowa, Philadelphia, Pa.

"BERYLDUR" EXPANDER is pushed down over plunger, then U packing is forced over the expander.

FURTHER INFORMATION about "Beryldur" is contained in this 4-page folder. Send for your free copy today.

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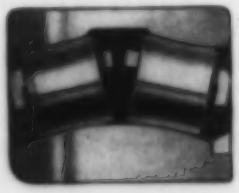
Link-Belt "Mill Bearings" are part of industry's most complete line of ball and roller bearing blocks.

STEEL PILLOW BLOCKS are the answer wherever bearings must withstand great shock and impact loads—as on steel mill, foundry, oil drilling, mining, construction and other heavy-duty equipment. That's why Link-Belt offers this line of Mill Bearings.

Perhaps your bearing demands are less extreme. Whatever your need, you'll find the right answer in this complete line of pillow blocks . . . plus flange, flange-cartridge, cartridge, take-up and hanger blocks and self-aligning roller bearings. Ask your nearest Link-Belt office for a copy of the helpful 120-page Data Book 2550 on the full line, and 8-page Book 2565-A on Link-Belt "Mill Bearings."

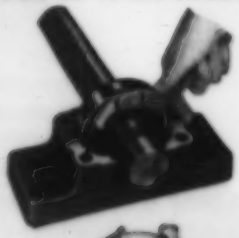
All these important differences are found only in Link-Belt "MILL BEARINGS"



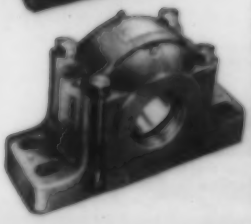
FREE-ROLLING SELF-ALIGNMENT. Adjusts immediately in all directions, assuring full load capacity, even when subjected to shaft deflections and inaccuracies of mounting. Important because "Mill Bearings" are subject to heavy, sudden shock loads.

ONE BASIC HOUSING accommodates either type of seal shown at left. They keep lubricant in and dirt out.

Left, Spiral Labyrinth Steel Seals for heat conditions, oil or grease lubrication. Right, combination felt and synthetic rubber contact type seal for dusty conditions, grease lubrication.



EASY INSTALLATION AND MAINTENANCE. Removal of cap means removal of bolts and hence no interference with assembly and inspection.



SUPER-RUGGED STEEL HOUSING. Four large heat-treated thru-bolts lock with heat-treated alloy steel serrated nuts to firmly clamp cap and base, permitting maximum radial and thrust loads. Big base area supports the bearing and withstands the extremely heavy pounding of mill and other grueling operations.

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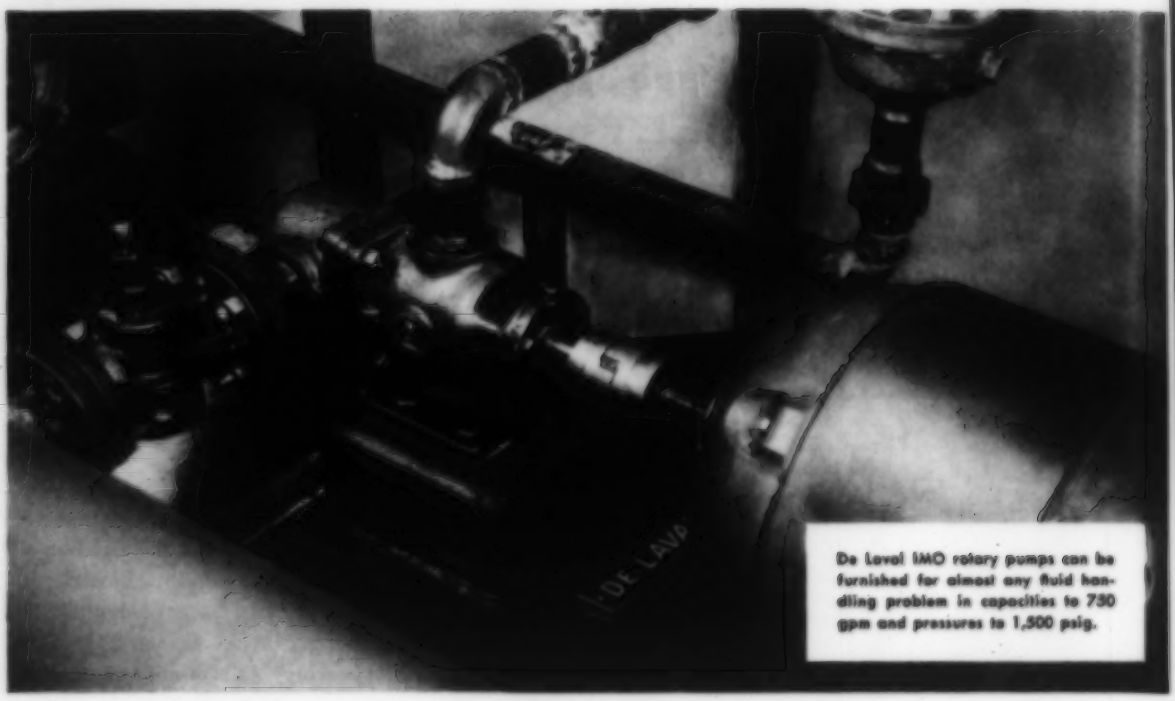


De Laval IMO rotary pumps can be furnished for almost any fluid handling problem in capacities to 750 gpm and pressures to 1,500 psig.

What to Look for in a Rotary Screw Type Pump

By W. J. MONCON, *Assistant Chief Engineer*
De Laval Steam Turbine Company

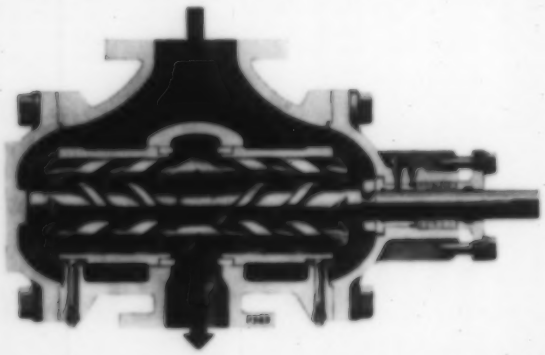
A sound knowledge of design, and how it affects performance, is the best insurance a buyer can have that he will get the pump he needs. This brief analysis of the IMO, a rotary three-screw pump manufactured by the De Laval Steam Turbine Company, will give you some of the necessary facts.

What qualities should you look for in a rotary type pump? It must, of course, meet specified capacities and pressures. But, it must also be efficient, operate quietly, stay on the job.

The axial flow of a screw type pump, and the resulting low inlet losses for any given pump speed, are important benefits that should be considered in making pump selections. The absence of timing gears and other mechanical features of construction also enable the De Laval IMO pump to operate at direct-connected motor and turbine speeds . . . to handle viscous liquids and high suction lifts.

One of the most important features of the IMO pump is the hydraulic turning of the idler or sealing rotors. The central or power rotor is the pumping element; the liquid pumped turns the sealing rotors.

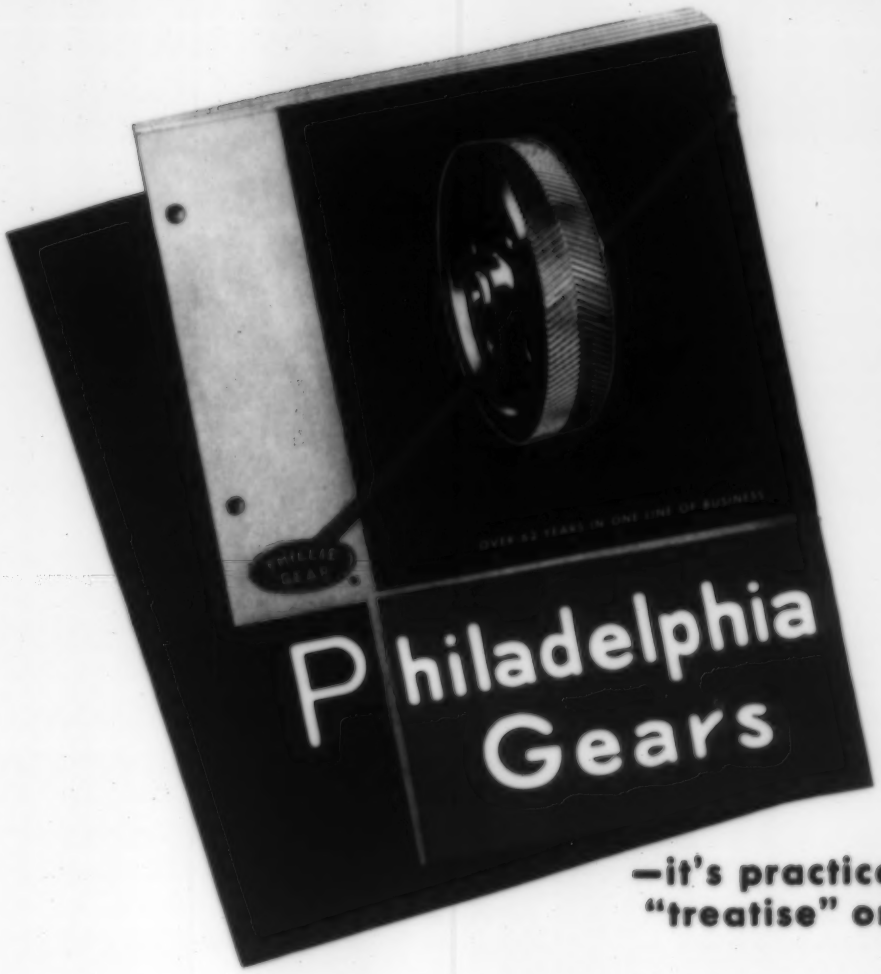
A screw type pump is well suited for applications where pulsation-free flow is desirable. The axial flow of the liquid without trapping and the unique thread form which keeps closures fluid-tight contribute to quiet operation of the IMO pump.



De Laval IMO Series A322A, a positive displacement, rotary screw type pump, can handle capacities to 750 gpm and pressures to 150 psig.

Catalog LS gives useful application and specification data on the IMO pump. An article titled, *Rotary Pumps, Basic Considerations in Their Application*, contains a description of rotary pumps in general. For these publications, write on your company letterhead to De Laval Steam Turbine Company, 858 Nottingham Way, Trenton 2, New Jersey. DL-301

NEW... *more than a catalog—*



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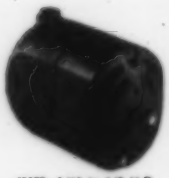

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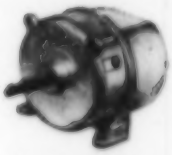
#312—1/20 to 1/10 H.P.

#700—1/8 to 1/2 H.P.

#2600—1/30 to 1/20 H.P.



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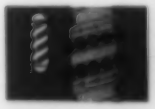

Like stripes on a barber pole, the balls travel toward end of nut through spiral "tunnel" formed by concave threads in both screw and mating nut.

the *Safety ball/bearing Screw* radically increases the efficiency of rotary-to-linear motion (and vice versa). Instead of *sliding*, mating surfaces *glide* on rolling steel balls.

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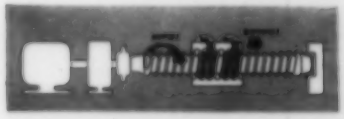

SAVES POWER—*Safety b/b Screw* requires only 1/3 as much torque for same lineal output as conventional Acme screw. With far lower static break-away, it operates with much less starting and driving power. This permits the use of much smaller motors with less load on the electrical system.

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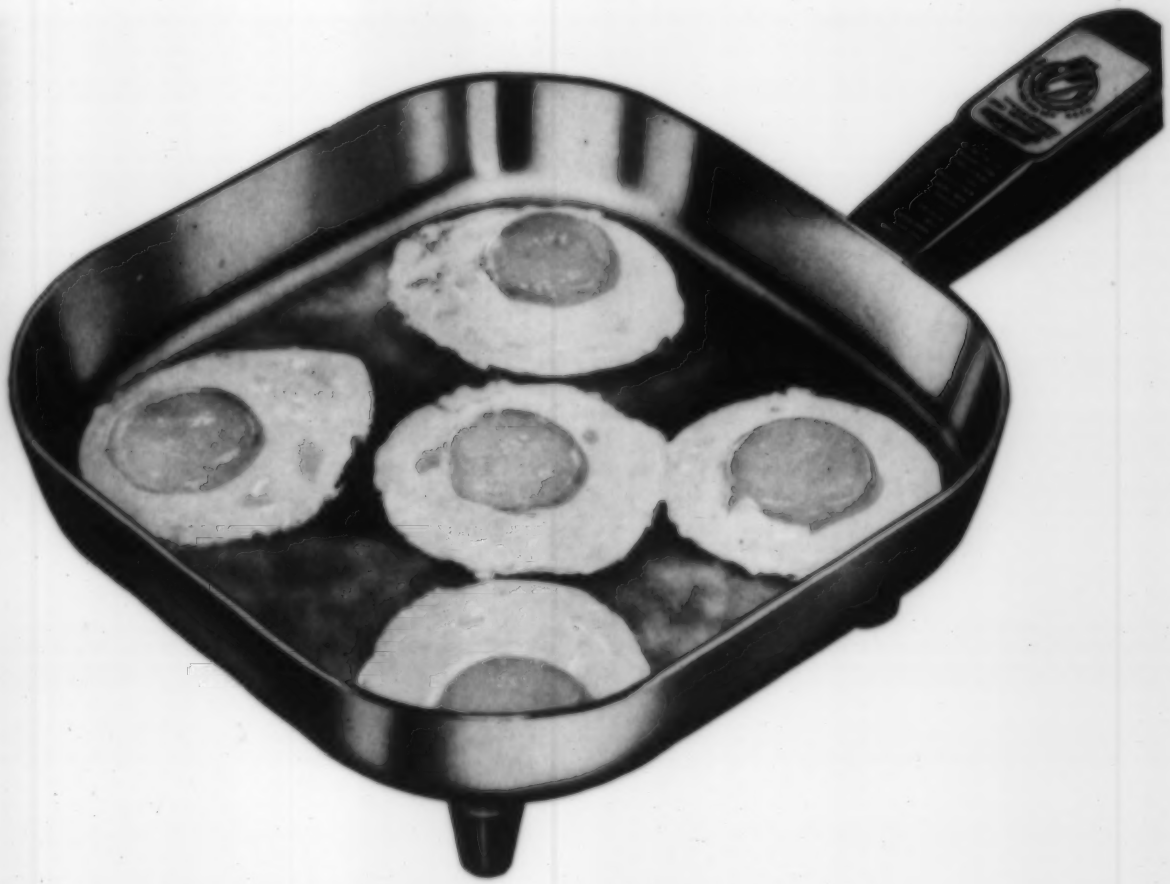
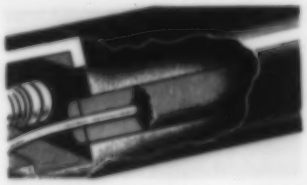


TRENTWELD stainless tubing chosen for connecting unit of new *Sunbeam* automatic frypan



TRENTWELD stainless tubing in handle of Sunbeam frypan

Two six-inch lengths of TRENTWELD stainless tubing form an important element of this popular new automatic frypan. One tube carries the electrical connection to the heating element embedded in the pan, and the other carries the dial connections to the thermostatic control. They make a tight, waterproof seal . . . and add strength to the bakelite handle.

You'll find more and more manufacturers specifying TRENTWELD for products ranging from frypans to heat exchangers. That's because you just can't buy better tubing than TRENTWELD, no matter what the application. TRENTWELD stainless and high-alloy tubing is a product of tube mill specialists.

And when it comes to sizes and finishes, Trent provides the widest range in the industry . . . standard sizes from ⅛″ to 40″ O.D. — larger sizes on special order. Next time you need tubing be sure and make it TRENTWELD.

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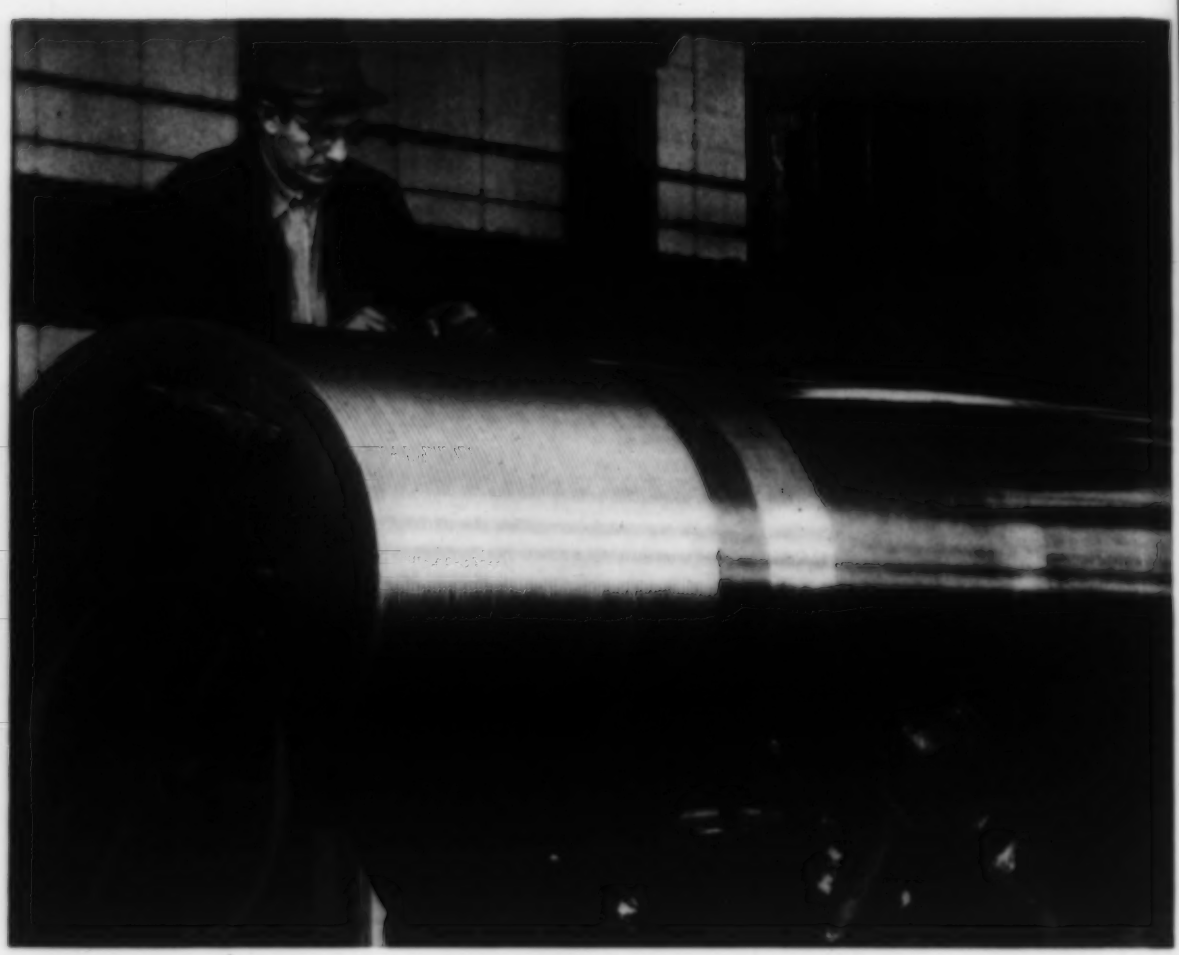

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This husky column stacks up as one of the most interesting jobs we've done in some time. Designed for a 15,000-ton hydraulic press, it is more complex than you might suspect at a casual glance.

The column proper, 50 ft long, is a heavy forging machined to a shipping weight of 73 tons. An axial hole nearly 10 in. in diameter runs through the entire length of the piece. Four big cylindrical nuts are threaded onto the column at specified intervals.

These nuts are castings. When in place on the column, they bring the weight of the assembly to almost 82 tons. Each of the nuts consists of two halves that are bolted together.

The job was done from beginning to end in the Bethlehem shops. It started with the making of the steel; later came all the steps of forging, casting, treating, rough- and finish-machining. It is an excellent example of Bethlehem's completely integrated services.

And don't forget, those services are always available for small jobs, as well as big ones. Though equipped to make pieces in excess of a hundred tons, we can also make you tiny drop forgings that hardly weigh a pound.

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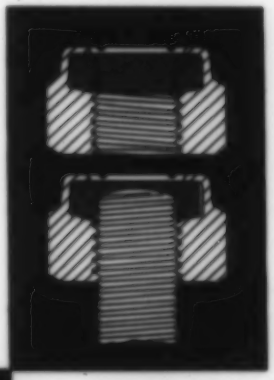
What's special about this STOP NUT?

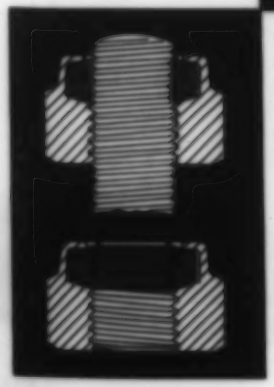
Several things make this nut unusual. For instance, you can "stop" it at any position on the threaded length of the bolt . . . or wrench it tight against the work where it protects bolt threads against corrosion and prevents liquid leakage. No matter where you leave it on the bolt, it will remain tight in that exact position, even though you subject it to heavy vibration and shock loads. But use a wrench on it and it comes off as easily as it went on. The red locking collar is nondestructive—does not gall bolt threads or remove plating. You can remove it and re-use it again and again.

What gives it its grip?

1 The locking collar is unthreaded and elastic. It has an inside diameter smaller than the major diameter of standard bolts.

2 The bolt impresses a mating thread into the collar and the resulting compressive forces exert a constant friction grip on the bolt. . . .





3 and exert a downward thrust bringing the lower flanks of the bolt thread into firm metal to metal contact with the matching nut threads, eliminating normal axial play.

4 Nut is removable and reusable . . . the Red Elastic Collar retains its grip after repeated usage.

Will it hold under ALL conditions?

The locking principle of the Elastic Stop® nut has been tested and proved by over 25 years of actual field service. Elastic Stop nuts are used on locomotives . . . and pile drivers. They fasten hedge shears and harvesters, drilling rigs and washing machines, trucks and roller skates. And no Elastic Stop nut customer has ever stopped using them because of unsatisfactory performance.

What about sizes and materials?

Elastic Stop nuts are available from a watchmaker's 0-80 all the way to 4"—in materials that include stainless steel, brass, aluminum and other alloys. Protect your product with "fastener insurance." Try Elastic Stop nuts on trouble spots, whether to protect expensive heavy equipment from costly downtime or to guarantee the accuracy of delicate electrical equipment by maintaining precision adjustments. We'll supply free test samples.

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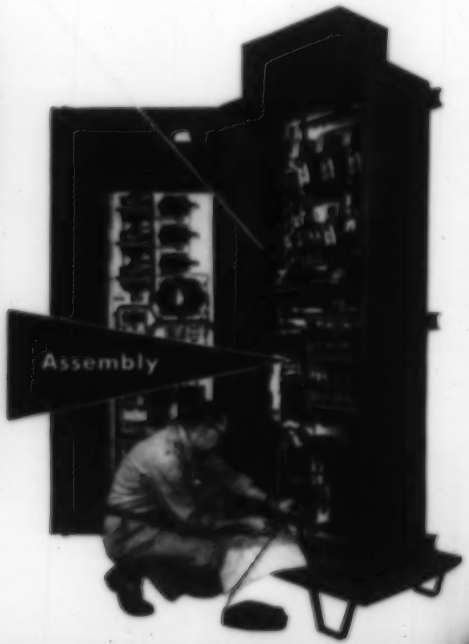

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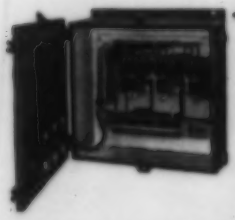
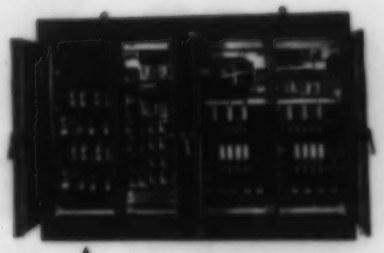


Square D builds special controllers ranging from those requiring only a few simple components *(at left)* to those employing hundreds of inter-connected devices *(below)* for controlling complex machine tools and processes.



A large AC-DC controller for machinery requiring both adjustable and constant speed motors.

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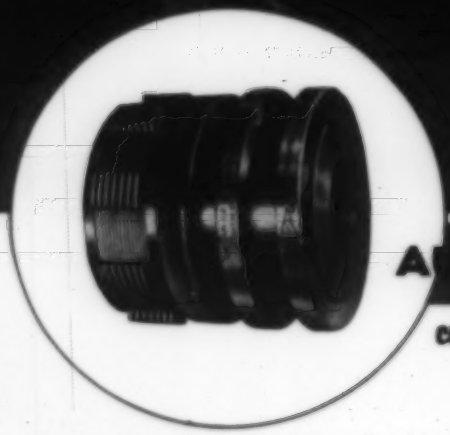

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controlled by MAXITORQ CLUTCHES

The photograph above shows the first installation by Sherman Enterprises, Inc., Worcester, Mass., of their automatic PINSETTER.

The pin boys have been replaced by this ingenious mechanism, a part of which is accurately controlled by Maxitorq floating disc clutches. Two solenoid-operated No. 22 clutches control (1) the elevator pick-up and setting of pins to correct position and (2) operate the distributor conveyor which carries forward the sorted pins. Alleys No. 2 and 10 show the automatic pin sweepers that clear the alleys for re-setting. Bowling balls are also automatically returned.

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DESIGNING WITH ALUMINUM

This is one of a series of information sheets which discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series will be supplied on request. Address: Advertising Department, Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

NO. 14 PREPAINT TREATMENT OF ALUMINUM

The prepaint treatment of aluminum is more important to the quality of the coating system than is the paint itself.

Depending on type of service, severity of exposure, and cost consideration, the prepaint treatment may vary from wiping the surface clean with a rag dampened in solvent to the application of a complex chemical conversion coating.

Three factors determine the quality of the finishing system:

1. Thorough cleaning and complete rinsing.
2. Proper choice and application of adequate surface preparation.
3. Specified application of proper paint system.

Cleaning

The five major methods of cleaning aluminum before further surface treatment are: 1. mechanical. 2. alkaline detergents. 3. emulsion cleaners. 4. organic solvents. 5. acid cleaners.

When the metal is heavily soiled, or when the soil is difficult to remove, two or more of these cleaning methods may be necessary.

Some types of metal soiling occur naturally. Other types of soil are intentionally applied during fabrication. The soil may consist of solid particles (metal chips, abrasive grains, shop dirt, etc.), organic substances (greases, soaps, buffing compounds, etc.) and corrosion products (oxides, etc.), each affecting the choice of the cleaning method.

These soils may vary greatly from one industrial plant to another or on different kinds of work in the same plant. Consequently, a universal cleaning process is not possible, and the selection of the proper cleaning method for removing each particular soil becomes as important as any other step in the entire painting procedure.

Table I may be used as a guide in selecting cleaning methods for certain types of soils. However, the advice and services of the suppliers of cleaners and cleaning machinery should be solicited.

Chemical Surface Treatments

Chemical surface treatments are designed to provide:

1. A surface that will provide the most "keying" for subsequent coatings.
2. A stable, adherent, corrosion resistant film that will protect the metal if the paint chips, cracks or flakes from a small area or spot and which will prevent the spread of corrosion under the paint film.

The chemical surface treatments that have been developed may be divided into two general groups; those produced with the aid of electrical current, and those produced without electrolytic action. The latter are known as chemical conversion coatings.

Anodic Electrolytic Process

Anodizing is the most widely used process for surface treatment of aluminum. Anodic coatings may be produced by

PLEASE TURN TO NEXT PAGE ➡

TABLE 1 **Article Prepared by the Kaiser Aluminum Metallurgical Research Department and Reprinted With Permission from *Western Industry*, October, 1954.**

	Mechanical Cleaning	Alkaline Cleaners	Emulsion Cleaners	Organic Cleaners	Acid Cleaners
TYPES	Shot blast. Grit blast. Wire brush. Sandpaper.	Hot or cold. Etching or non-etching. Immersion. Spray.	Immersion. Spray.	Solvent wiping. Solvent immersion. Vapor degreasing.	Organic and inorganic acids. Usually mixture of two acids.
USES	Castings. Rough work. Heavy pieces. Removes surface dirt and corrosion products.	Best for removal of widest range of soils. Etching type good for corrosion products.	Removes oil, grease, and some loose dirt. No effect on corrosion products.	Removes oil, grease and some loose dirt. No effect on corrosion products.	Removes corrosion products or pickle. Neutralizer after alkaline cleaning. Smut removal.
EFFECTIVENESS	Provides mechanical adhesion. Removes surface metal and oxide.	Most effective of the group. Better with acid rinse.	Not effective on adherent soils or corrosion products.	Since the dissolved oil and grease remain in solution, some is redeposited.	Best if used in conjunction with alkaline cleaners or vapor degreasers. Some types used as paint base.
AFTER-TREATMENT	Further cleaning and treatment required for best results.	Neutralize with acid dip or for conversion coating rinse with water.	For best results follow with alkaline or acid cleaner.	For best results follow with alkaline or acid cleaner.	Water rinse.
PRECAUTIONS	Blasting of any type may distort thin sections.	Aluminum is readily dissolved by alkali. Use inhibited solution.	Thorough after-rinse necessary.	Some solvents inflammable, others toxic.	Acids improperly used create health hazards.

TABLE 2	Chromic acid anodizing	Sulfuric acid anodizing
TYPE OF COATING	Gray to greenish-gray impervious oxide film in the range of 0.00003 to 0.0001 in. thick.	Porous oxide film of various color depending on the alloy. Thickness from 0.001 to 0.002 in.
PROPERTIES	Excellent corrosion resistant. Excellent paint base. Good abrasion resistance. Limited as mordant for dyes.	Corrosion and abrasion resistant base for paint. Excellent mordant for dyes.
APPLICATION PROCEDURE	1. Hot mild alkaline cleaner. 2. Cold water rinse. 3. Parts made the anode in a 5–10% solution of chromic acid at 95 deg. F. 4. Increase voltage gradually over 5 minute period to 40 v. Hold for 30 min.	1. Hot mild alkaline cleaner. 2. Cold water rinse. 3. Parts made the anode in a 10–25% solution of sulfuric acid at 65–90 deg. F. and 15–20 v. 4. Hold for 20–30 min. 5. Cold water rinse.
COMMENTS	1. Agitation by air or mechanical stirrer is desirable during processing. 2. May be used on assembled parts since entrapped acid has very little effect on corrosion.	1. Suitable for all alloys of aluminum. 2. Not acceptable on assembled or formed parts where acid may be trapped, because of danger of corrosion by entrapped acid.

many different methods with various degrees of hardness, porosity and thickness. The surfaces they provide are resistant to corrosion and abrasion and are an excellent base for organic finishes. Of the many electrolytes that can be used, the sulfuric acid and chromic acid types have received the widest acceptance in the United States. The important features of each are shown in Table II.

Continuous anodic coating of coiled aluminum strips. Picture courtesy of Monarch Metal Weatherstrip Co.

Conversion Coatings

Only a limited number of chemical conversion coatings for aluminum have been extensively used commercially. They are well adapted to modern production requirements. One of the oldest and best known of these is the M.B.V. (modified Bauer-Vogel) process. The oxide coating it produces is not as hard or thick as an anodized coating, but it is adequate for some applications. Parts to be treated are immersed in an alkali carbonate–alkali chromate solution. Following this immersion, they are rinsed in cold water, then in hot water, and then dried. This treatment produces a good bonding surface for paints, but it is not well suited to aluminum alloys containing more than 5% copper.

Two types of phosphate conversion coatings to come out of World War II as treatments for aluminum are the complex chromate phosphate fluoride coatings and the zinc phosphate coatings. Each of these coatings has many desirable properties and a wide range of applications. The complex chromate phosphate fluoride coating differs from the other phosphate treatments in that the film produced is amorphous rather than crystalline. Since it can be applied by spray or dip following conventional precleaning, it is well suited to mechanized finishing procedures. This type of coating offers an excellent base for paints. The zinc phosphate coating, originally developed for iron and steel, has been adapted to use with aluminum. This type of coating produces a film on aluminum that increases the corrosion resistance and paint adherence of the surface. The outstanding feature of the zinc phosphate coating is that parts with mixed metal surfaces may be successfully treated in one operation. Most surface methods do not have this feature.

Several further improvements in chemical conversion coatings have recently been introduced in the form of chromate finishes. These coating solutions may be applied by brush, spray or dip and the contact times required are relatively short, ranging from seconds to eight minutes. Consequently, they are well suited to automatic equipment. A crystalline chromate coating can be used as a final finish on aluminum or as a base for subsequent paint films.

Automatic phosphatizing of 155 mm. shells. Picture courtesy of Cincinnati Cleaning & Finishing Machinery Company.

One important feature claimed for these new chromate coatings is that they have a minimum effect on the electrical properties of aluminum to be used in either low or high frequency work. Their potential field of application is quite great. As they become more widely used, improvements and modifications are sure to appear. For further information concerning the pre-paint treatments available for aluminum, contact the Kaiser Aluminum sales office listed in your telephone directory, or one of our many distributors. Kaiser Aluminum & Chemical Sales, Inc., General Sales Office: Palmolive Building, 919 North Michigan Ave., Chicago 11, Illinois; Executive Office: 6877 Kaiser Building, Oakland 12, California.

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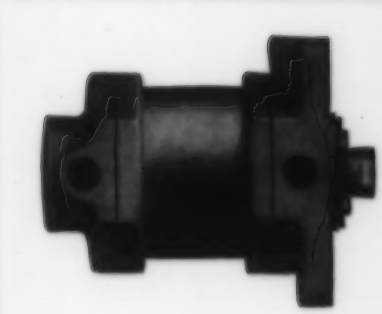

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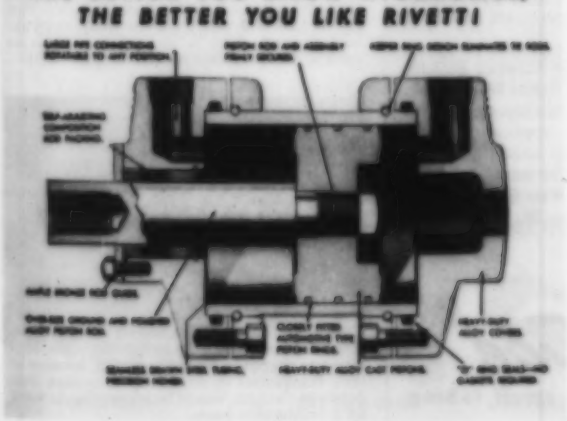

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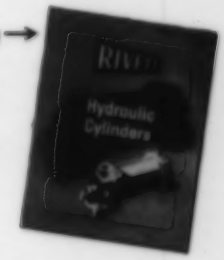
RIVETT LATHE & GRINDER, Inc.
Dept. MD-8, Brighton 35, Boston, Mass.



Representatives In All Principal Cities

Member—National Fluid Power Association

RIVETT furnishes a complete power package

AIR AND HYDRAULIC — VALVES, CYLINDERS, POWER UNITS

Using the Sheffield-Cavitron Ultrasonic Machine Tool to dice germanium in the mass production of transistors. The tool itself consists of 271 pieces of Superior's 18-gage Type 304 needle tubing, cut to ⅛" lengths and silver brazed into a single tool, permitting tolerances as fine as .0005".

NEW ULTRASONIC MACHINE TOOL USES TUBING TO CUT HARDEST, MOST BRITTLE MATERIALS KNOWN

a new application for Superior Tubing

Ultrasonic vibrations do the cutting with this new machine tool, invented and developed by the Cavitron Equipment Corporation, Long Island City, N.Y. In the Cavitron process, a tool is used which has the precise shape of the cavity desired. Finely divided abrasive particles suspended in water are flowed continuously across the work. No movement or vibration is visible when the machine is switched on, although the tool tip vibrates 20,000 times a second through a stroke of .0035". The vibrating tip activates the suspended particles, and microscopic chips are gently excavated without heat, noise or vibration. The tool sinks swiftly into the work under slight pressure, forming a cut or cavity of exactly the same shape as the tip.

Tools made of Superior tubing save considerable cutting time on relatively large areas. Furthermore, the slender walls (.005" thick) minimize waste of valuable raw material. Cavitron engineers first used carbon tubing for this purpose, but in consultation with Superior engineers switched to AISI Type 304. This material has twice the life of carbon tubing, with much greater resistance to wear. Most important, it resists warping at the silver brazing temperatures needed to join the tubes together.

Your files should contain Superior Bulletin No. 40. It lists over 55 types of available material, including the stainless steels, with valuable selection and application data. Write for your free copy today. SUPERIOR TUBE COMPANY, 2010 Germantown Ave., Norristown, Pa. *On the West Coast:* Pacific Tube Co., 5710 Smithway St., Los Angeles 22, California.

All analyses available in .010" to ¾" OD; certain analyses in light walls up to 2½" OD

Superior Tube

The big name in small tubing

Superior tubes are cut into 2" lengths and silver brazed into a 6-sided tool, which is then cut in half and two complete honeycomblike tools formed—each ⅜" deep. Similar tools are used to cut precision jewel bearings.

Closeup of tool and work shown in top picture. The Cavitron makes it possible to cut and drill intricate shapes in materials which, because of their frangibility or sensitivity to sudden temperature changes, would be impossible to work on a production basis.

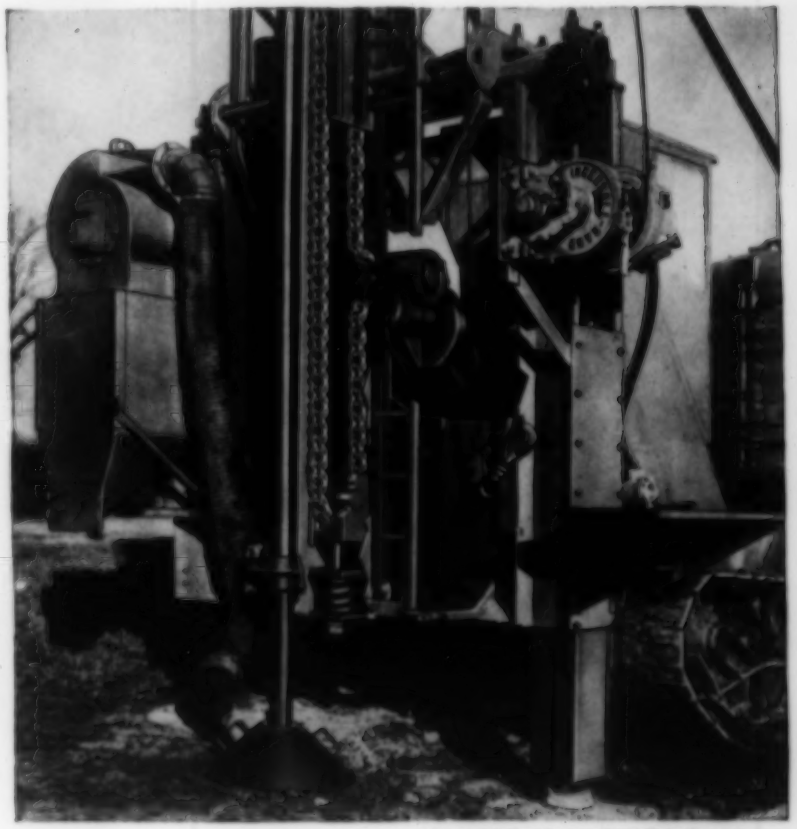
These LINK-BELT Roller Chain EXTRAS

put more life into your machines

LOCK-TYPE BUSHINGS (applied on a range of sizes) end a common cause of stiff chain.

PRE-STRESSING of multiple width chain provides uniform load distribution.

SHOT-PEENED ROLLERS have greater fatigue life, added ability to withstand impact.



Ingersoll-Rand uses Link-Belt Precision Steel Roller Chain for positive drill feed on their Quarrymaster primary blasthole drill.

THROUGHOUT every stage of manufacture, Link-Belt takes *extra* care to build *extra* life into Precision Steel Roller Chain. Shown above are three of these added refinements . . . and there are many others which contribute to better performance and longer life for your machines.

You can choose from a wide range of Link-Belt roller chains and sprockets. In addition, Link-Belt's complete line includes silent chain drives . . . and all sizes and types of cast, combination, forged and fabricated steel chain.

Data Book 2457 will aid you in selecting and ordering roller chain. Get your copy from the nearest Link-Belt office now. And remember to see Link-Belt for all your drive and conveying chain needs.

LINK-BELT

CHAINS and SPROCKETS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

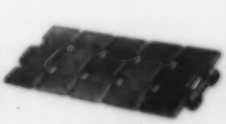
13,700

No one chain serves every purpose . . . get the RIGHT one from Link-Belt's complete line

Silent Chain

LXS Steel Chain

Detachable Steel Link-Belt



S-815 Flat-Top Chain

Cast and Cut-Tooth Sprockets

SEE FOR YOURSELF

where FARREL GEAR UNITS get their CAPACITY FOR WORK

As you can see, the full face width of each gear in a Farrel speed reducer is at work, transmitting power.

Instead of a center groove, Farrel gears have a ***backbone*** formed where the helices meet. This ***backbone*** provides extra strength, and greater load-carrying and shock capacity—especially important in tough-job applications.

What you can't see, but which is equally important, is that these gears have teeth generated by the famous Farrel-Sykes method—assuring accuracy of tooth spacing, profile and helix angle. This accuracy pays off in smooth, quiet, uniform power flow.

Farrel speed reducers are made in a number of types, with a wide range of ratios and capacities. For more about these long-lived units ask for a copy of bulletin 449.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT

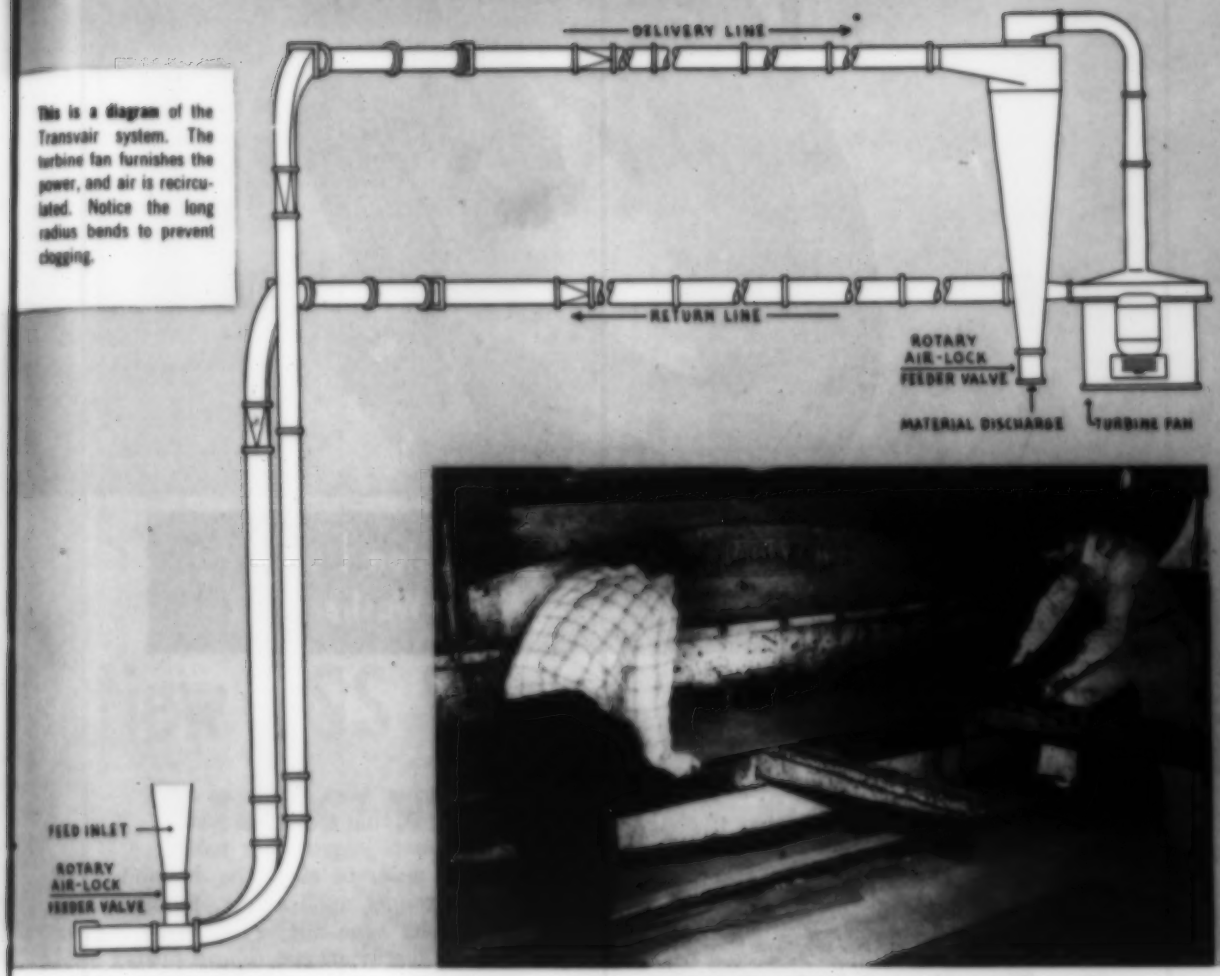
Plants: Ansonia and Derby, Conn., Buffalo and Rochester, N.Y.
Sales Offices: Ansonia, Buffalo, New York, Boston, Akron, Detroit, Chicago, Memphis, Minneapolis, Fayetteville (N. C.), Los Angeles, Salt Lake City, Tulsa, Houston, New Orleans

FB-991

Farrel-Birmingham®

How Stainless Steel prevents contamination in pneumatic transfer system

This is a diagram of the Transvair system. The turbine fan furnishes the power, and air is recirculated. Notice the long radius bends to prevent clogging.



Stainless Steel presents no fabricating problems at Young Machinery Company. This standard shear, for example, is used to cut both ¼" carbon steel and 10-gauge Stainless Steel.

Young Machinery Company makes a unique line of air conveyors that transfer dry, free-flowing materials through tubing. Energy is furnished by a turbine fan, and the entire system is sealed so that hazardous and toxic substances can be handled with safety.

Since contamination is a problem, the systems are frequently made from Stainless Steel. The first time that Young used this metal was in 1949, but now it accounts for 50% of their total production.

These systems are frequently used to move corrosive solids in the chemical industry – a natural use for Stainless Steel. Then, too, foodstuffs are often handled; and the dense, easy-to-clean surface of Stainless Steel is unmatched for this service.

There have been no production difficulties. Identical equipment is used for fabrication of Stainless Steel or carbon steel. In fact, it was not necessary to buy new equipment or even modify the older machinery when Stainless Steel was used.

No other metal combines the easy fabrication, corrosion resistance, high strength and cleanliness of Stainless Steel. If you plan to use this durable metal, remember that United States Steel has the nation's largest assortment of Stainless Steel shapes, sizes, types and finishes.

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

USS STAINLESS STEEL

SHEETS • STRIP • PLATES • BARS • BILLETS • PIPE • TUBES • WIRE • SPECIAL SECTIONS

UNITED STATES STEEL

Tight Fastenings Require Constant Tension . . . use Dependable Spring Lock Washers

Reliance Spring Lock Washers are available for the job, wherever constant tension is required in bolted assemblies. In order to meet the demand for special fastening applications, Reliance has developed various type Spring Washers to meet exacting specifications. These Spring Washers, as illustrated, are now in stock to help solve your fastening problems before they get started.

Scientifically engineered Reliance Spring Lock Washers will keep the bolted assemblies of your products tighter longer.

Send for Engineering Bulletin W-50 for a look at the complete line. No obligation, of course.

RELIANCE DIVISION EATON® MANUFACTURING COMPANY

OFFICE and PLANTS: 506 Charles Ave. MASSILLON, OHIO

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How to use
New USS "T-1" Steel
to reduce welding costs

New USS "T-1" Steel is three times as strong as ordinary mild steel . . . has a yield strength of 90,000 psi.

Yet, despite its very high strength, this new alloy steel is *easy to weld*. It requires neither pre- nor post-heating when you weld or flame cut it. You can use its unique combination of properties to reduce fabricating costs and speed assembly in pressure vessels, construction machinery, mining equipment, bridges, towers, and pipe.

USE "T-1" TO REDUCE THICKNESS. You can take advantage of the exceptionally high yield strength of "T-1" Steel to reduce the size and weight of heavily stressed parts. Weldments on thinner sections take less time . . . and less welding rod.

FABRICATE "T-1" IN THE FIELD. You can weld "T-1" Steel *anywhere*. Since no pre- or post-heating is needed, you don't have to confine fabrication to locations where heat treating facilities are available. You can assemble heavy-duty equipment in the field, and you can repair it in the field—at great savings.

WHAT ABOUT JOINT EFFICIENCY? Weldments in "T-1" Steel develop the full yield strength of the steel — 90,000 psi.—when made with AWS E12015 low hydrogen coated electrodes *without* pre- or post-heating. As a result, weight reducing designs based on the greater strength of "T-1" Steel are completely safe and reliable.

Send the coupon for complete facts about this amazing new alloy steel.

United States Steel, Room 4855
525 William Penn Place, Pittsburgh 30, Pa.

☐ Please send me your booklet "United States Steel presents T-1" which contains the full story of "T-1" steel.

☐ Have your representative get in touch with me.

Name .....

Address .....

City ..... State .....

UNITED STATES STEEL CORPORATION, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. • UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS "T1" CONSTRUCTIONAL ALLOY STEEL

USS

SEE THE UNITED STATES STEEL HOUR. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

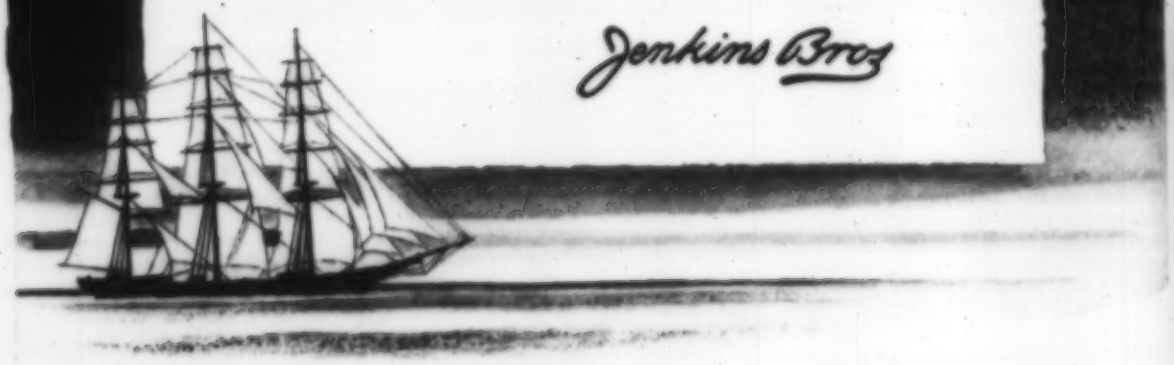
S-477

UNITED STATES STEEL

A Fair Offer

If you will put a Jenkins Valve, recommended for your particular service, on the worst place you can find — where you cannot keep other valves tight — and if it is not perfectly tight or it does not hold steam, oil, acids, water or other fluids longer than any other valve, you may return it and your money will be refunded.

Jenkins Bros



"A Fair Offer", first published in 1869, was more than a warranty of superior performance. It charted a course for fair dealing from which Jenkins Bros. has never veered.

By making valves that measure up to this forthright offer, Jenkins Bros. has continued to set the highest standards for quality.

"A Fair Offer" is republished, at regular intervals, as our pledge that those standards will always be observed.

Sold Through Plumbing - Heating and Industrial Distributors

JENKINS VALVES

LOOK FOR THE JENKINS DIAMOND

USS COR-TEN STEEL

gives strength and extra corrosion resistance to hull of pleasure yacht

The pride of Ingalls is the new Rhonda III. This new yacht, which features many other new shipbuilding practices in addition to the use of light weight, corrosion-resistant COR-TEN Steel hull construction, was designed by M. Rosenblatt & Son, Naval Architects and Marine Engineers of New York City.

The Ingalls Shipbuilding Corp., of Birmingham, Alabama, has been constructing ocean-going vessels of many types for more than 25 years. This vast experience paid off when it came to the design of this beautiful new-type 96 foot yacht—and the decision to use USS COR-TEN High Strength Steel to give extra strength and corrosion resistance to the Rhonda's hull.

In a new booklet describing many of the unusual features of their new RHONDA III, The Ingalls Shipbuilding Corp., explains their reasons for the choice of USS COR-TEN High Strength Steel:

"Rhonda III is constructed almost entirely of all-welded COR-TEN corrosion-resistant steel. No rivets whatsoever are used. Most hull plating is 7.65 pounds or $\frac{3}{16}$" thick. Early in the design stage extensive investigations and tests of specially designed steel panels with widely spaced weld beads were conducted to determine optimum size and length of welds for the best possible combination of strength and fairness. In the opinion of the designers, whose experience covers many years of foreign as well as domestic yacht and ship building, RHONDA III's hull is the finest example of a fair light welded steel hull. Despite this, strength and sea-worthiness have in no way been compromised."

Here again USS COR-TEN High Strength Steel was selected because of its proved ability to reduce deadweight and to stand up under corrosive conditions—even when it's the severe combination of salt water and ocean atmospheres.

NOW AVAILABLE . . . our new "Design Manual for High Strength Steels" is ready for distribution. This excellent book contains comprehensive and practical information that you will find extremely useful in designing your product for greater economy and efficiency by the sound use of high strength steels.

For your free copy, write on your company letterhead, giving title or department, to United States Steel Corporation, Room 4741, 525 William Penn Place, Pittsburgh 30, Pa.

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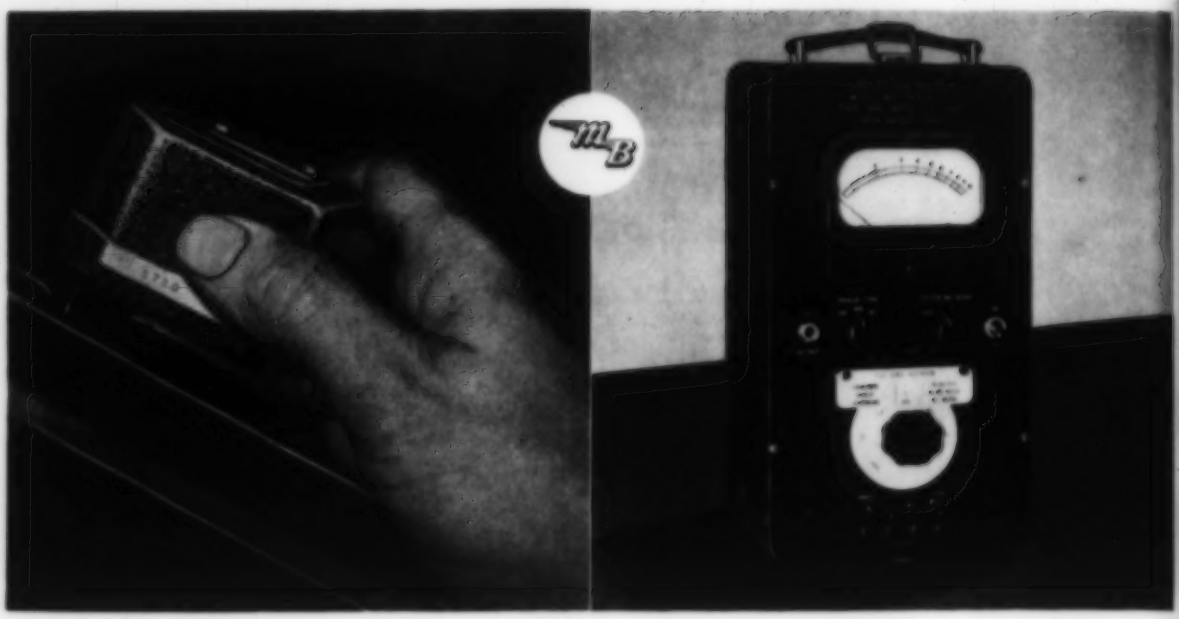
USS HIGH STRENGTH STEELS

USS MAN-TEN · USS COR-TEN · USS TRI-TEN

USS

5-1827

Two new "tools" to help you pin point vibration



MB Probe-type Pickup and Portable Meter

simplify reliable vibration detection and measurement

Here's the pickup that really searches out vibration. It combines the extreme sensitivity of electromagnetic operation with the wide usefulness of a hand-held probing instrument.

With this new MB Type 115 Pickup, you can explore large panels . . . bearings, housing, structural members, bodies large and small. Since the light probe adds negligible loading or weight to the vibrating object, it translates any vibration into voltage with great accuracy for measurement. It lets you pin-point the trouble . . . determine quickly any need for corrective design.

The improved Model M6 MB Vibration Meter teams up with the pickup to give you the facts on vibration. With it, you measure the voltage generated in the pickup directly . . . in useful terms of amplitude, velocity, or acceleration of the vibratory motions.

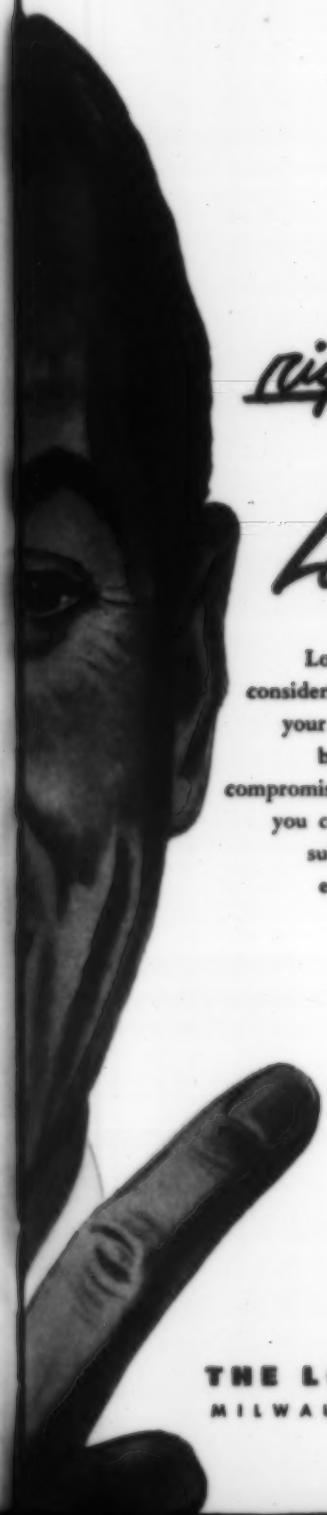
You can connect as many as four MB Pickups to this meter . . . a selector switch enabling you to read any one at a time. The meter is portable, compact, ruggedized and operates on standard AC.

To lick vibration, you've got to locate it first. You'll find this pair a big help for that job. Write for more data.

the MB *manufacturing company, inc.*

1060 State Street, New Haven 11, Conn.

HEADQUARTERS FOR PRODUCTS TO *ISOLATE* VIBRATION...TO *EXCITE* IT...TO *MEASURE* IT



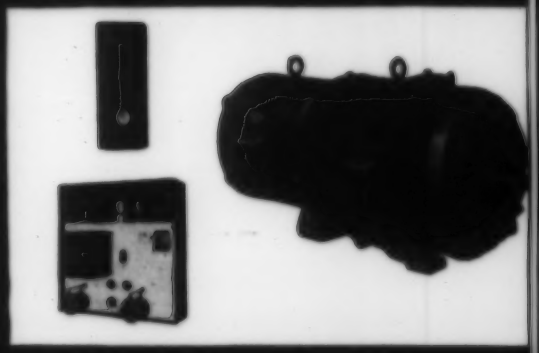
A complete adjustable speed line

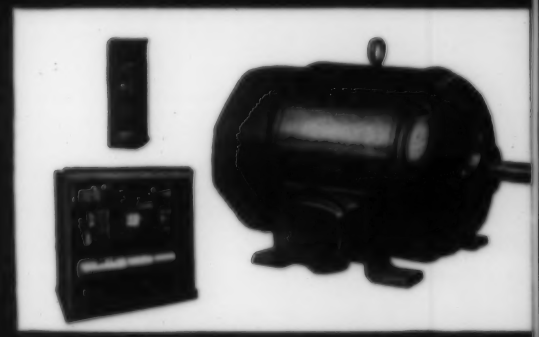
Get the right answer from Louis Allis

It pays to think first of the Louis Allis Co. whenever you're considering adjustable speed drives for your product or plant. Louis Allis builds all basic types. There's no compromising — from this complete line you can select the unit that's exactly suited to your job conditions and engineered for your application.

For the simplest — and best — solution to any adjustable speed drive problem, call your nearby Louis Allis Sales Engineer, or write to us.

THE LOUIS ALLIS CO.
MILWAUKEE 7, WISCONSIN





ASD-101

CHOOSE THE *RIGHT* LATCH TO DO THE JOB *BEST!*

SOUTHCO DOOR AND PANEL LATCHES

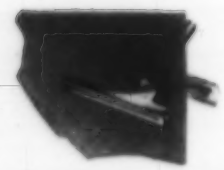
UNIQUE DESIGNS ASSURE LOW INSTALLED COST

FOR ECONOMY . . .
LONG LIFE . . .
EXTRA SALES APPEAL . . .

Here's a variety of rugged, smooth-operating door fasteners designed for countless applications where both economy and smart appearance are important.

Built for long life, SOUTHCO latches hold panels and other closures *pressure tight* to resist vibration and keep out dust . . . despite variations in door and frame thicknesses.

For speedy, uncomplicated installation, using a minimum of parts and requiring fewest possible tools, SOUTHCO latches are unexcelled.



UNIVERSAL CABINET LATCH

For extra fast installation on all sheet metal doors. No welds, bolts, screws, or rivets needed. Adjustable to any grip length. Brightly finished knob and plated washer make this an appealing fastener for smart appearing cabinets.

ADJUSTABLE PAWL FASTENER

Automatically adjusts, by a turn of the knob, to various door or frame thicknesses. Pre-assembled for fastest installation. Knobs are brightly plated to improve appearance of equipment. Choice of three body sizes. Choice of pawls offers wide variety of adjustable grip lengths.

SLIDING LATCH

Seals door and frame together under pressure with just a turn of the knob. Permits easy alignment, smooth operation. No part of latch is inside door. Appearance is suitable for the best finished products. Also an inside model with only locking screw visible.

Which of these SOUTHCO latches can serve you best? Write us for full information. Southco Division, South Chester Corporation, 237 Industrial Highway, Lester, Pa.

©1955

ARROWHEAD PANEL LATCH

Ideal for slide-out drawers, removable or hinged panels. Locks or opens quickly with a quarter turn. Holds doors shut under spring tension. Uses minimum inside space.

DOOR LATCH

Meets the need for a low-budget fastener for control boxes, machinery, hot water heaters, and other light gauge sheet metal closures for home or industrial use. Just two simple parts, installed in seconds *with only a pair of pliers*. No striker plate needed. Also available in a screwdriver operated model.

SOUTHCO

FASTENERS

PAWL • SCREW AND SPRING • DRIVE RIVETS • ANCHOR NUTS • ENGINEERED SPECIALTIES

OFFICES IN PRINCIPAL CITIES

WHEREVER TWO OR MORE PARTS ARE FASTENED TOGETHER, STANDARD AND SPECIAL DESIGNS FOR IMPROVED PERFORMANCE AND LOWER PRODUCTION COSTS

in Bearings as in Bergs,
BIG THINGS ARE FOUND BENEATH THE SURFACE
SKF
BALL AND ROLLER BEARINGS

SKF
makes them all

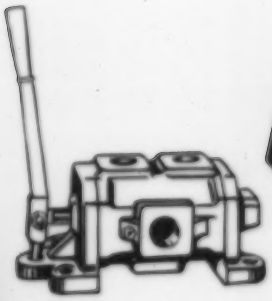
SKF's comprehensive line of Filling Slot and Deep Groove Ball Bearings (some of which are shown here) is typical of the complete bearing service which SKF provides. That is why you get unbiased advice based on exceptionally *broad* experience when SKF's product-assistance staff helps you put the right bearing in the right place in your product.

Single Row, Filling Slot (Max Type) Ball Bearings

Single Row, Deep Groove Ball Bearings

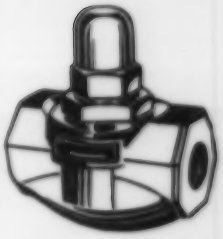
BALL AND ROLLER BEARINGS

Logan HYDRAULIC VALVES.....



Illustrated, Model 4095 —4-way, 2-position valve for directing pressure alternately to ends of double-acting hydraulic cylinder.

Illustrated, Model 8015 adjustable speed control valve. Install between operating valve and one end of cylinder to meter flow of oil in one direction with free flow on return.



A broad range of types and sizes to most effectively meet any requirement—Design Engineers, Machine Operators, Maintenance Men appreciate these Logan advantages

- LONG-LIFE CONSTRUCTION
- EASY TO SERVICE
- INFREQUENT MAINTENANCE
- EASE OF INSTALLATION
- EFFORTLESS OPERATION
- UNRESTRICTED PORTING

On your products and in your plant, the enlarged line of standard Logan Hydraulic Control Valves offers many profitable advantages in selection, installation, use and maintenance. Standard Logan Hydraulic Valves are designed for 1500 psi service. The broad range of types and sizes makes it easy to select the most effective valve for every problem.

Balanced-pressure construction of these piston-type valves places identical pressure on both ends of the piston, thus providing effortless operation.

All ports and internal chambers are full pipe size with valve piston light in weight, thus assuring rapid response and fast reversal without excessive vibration or wear.

Highly compact design permits easy installation in restricted areas. Master control valves have four mounting feet located on end covers for easy mounting.

The valve body, which includes the ports, can be rotated 360° on the end covers to four positions at 90° intervals, when socket-head cap screws are removed from the covers. Permits convenient and efficient location of pipe connections. Alternate inlet ports, with one port plugged, provide added flexibility.

The ease with which pipe connections can be made often eliminates the necessity for costly special valves. Elimination of elbows, street ells, bends, etc. minimizes internal friction, thereby increasing efficiency and reducing costs.

The tough, wear-resistant alloy steel piston, hardened and ground, provides a close, sliding fit in the valve body. Both body and end covers are chrome nickel iron castings which furnish a good bearing surface to assure superior wearing qualities.

Both wear and maintenance are reduced in the Logan sliding-piston construction through elimination of valve seats and packing. The two stem seals at ends of piston are subject only to exhaust pressures.

With the removal of end covers, the standard seals are easily replaced and the piston may be removed from the vaive body for examination without disconnecting the piping.

Logan Hydraulic Control Valves offer many other advantages which assure longer, more effective performance and low maintenance.

For full information write for Logan Catalog 200-4.

Let Logan Engineers help you design your Air and Hydraulic Circuits. You will not be obligated.

Wherever there's a holding or motion requirement, there's a Logan design to do the job.

Member—National Tool Builders Assn.; National Fluid Power Assn.

LOGAN MANUFACTURES 7,023 STANDARD CATALOGED ITEMS

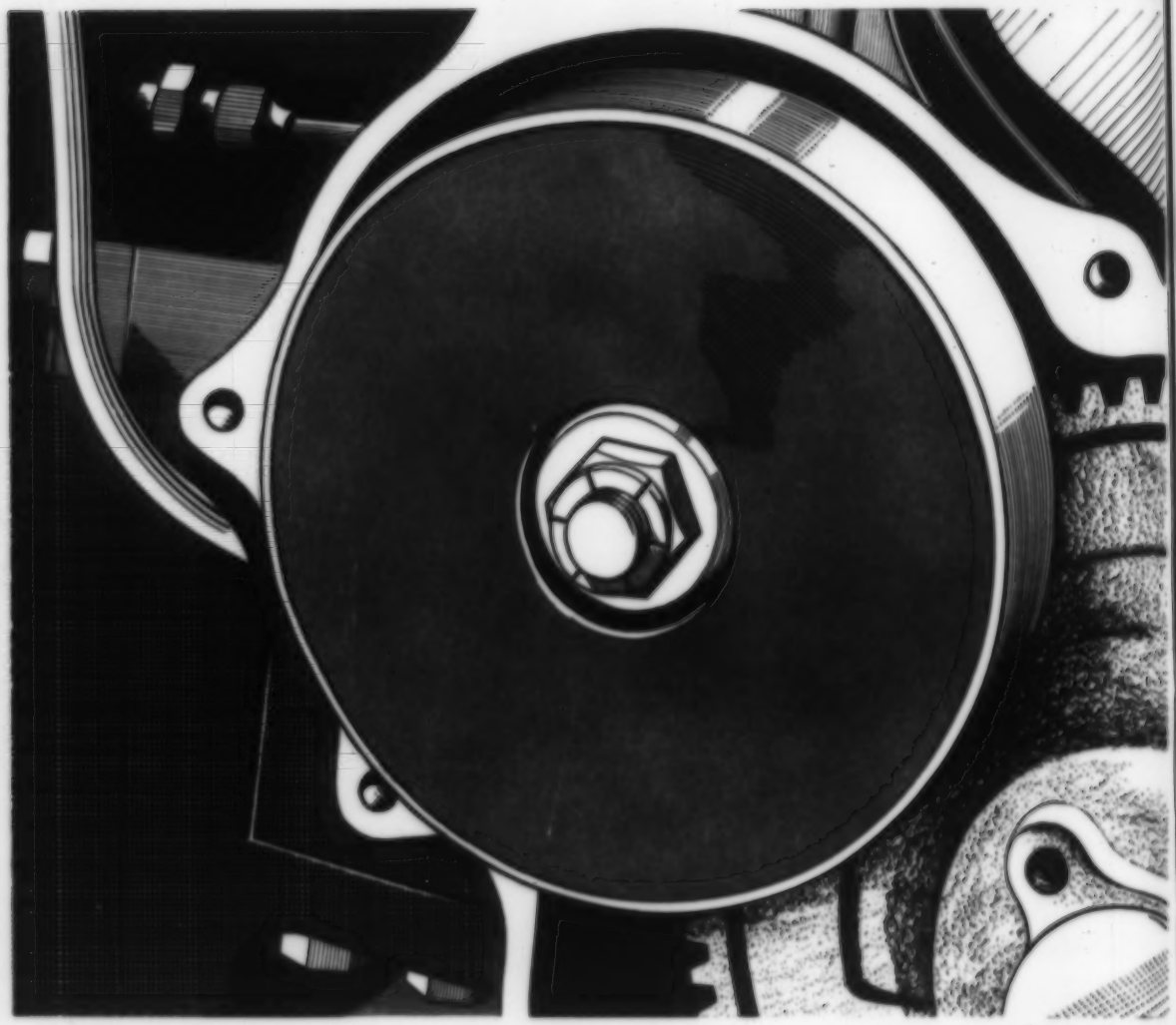
FREE CATALOG ON REQUEST

AIR CONTROL VALVES, Cat. 100-4 • AIR CHUCKS, Cat. 70-1 • AIR CYLINDERS, Cat. 100-1 • AIR-DRAULIC CYLINDERS, Cat. 100-3
AIR and HYDRAULIC PRESSES, Cat. 51 • COLLET GRIP TUBE FITTINGS, Cat. 200-5 • HYDRAULIC CONTROL VALVES, Cat. 200-4
HYDRAULIC CYLINDERS, Cats. 200-2; 200-3 • HYDRAULIC POWER UNITS, Cat. 200-1 • SURE-FLOW COOLANT PUMPS, Cat. 62

SAVES TIME Logan AIR AND HYDRAULIC EQUIPMENT SPEED • MOTION

LOGANSPORT MACHINE CO., INC., 811 CENTER AVE., LOGANSPORT, IND.

FLEXLOC AT WORK



MORE AND MORE FLEXLOC LOCKNUTS are being used where assemblies must be held together. This electric chain saw is a good example of an application for which FLEXLOCS are well suited.

A FLEXLOC Self-Locking Nut is used here to hold the driver gear in place. Even high-speed cutting, extreme vibration, and rough handling do not loosen the FLEXLOC locknut. These one-piece, all-metal locknuts are available in a full range of sizes. Standard FLEXLOCS are stocked by authorized industrial distributors in sizes from #4 to 2". Write for Bulletin 866 and samples. STANDARD PRESSED STEEL CO., Jenkintown 18, Pa.

DO YOU KNOW? Standard FLEXLOCS smooth off rough bolt threads. The locking threads on all-metal FLEXLOCS are not chewed up when used on rough bolts.

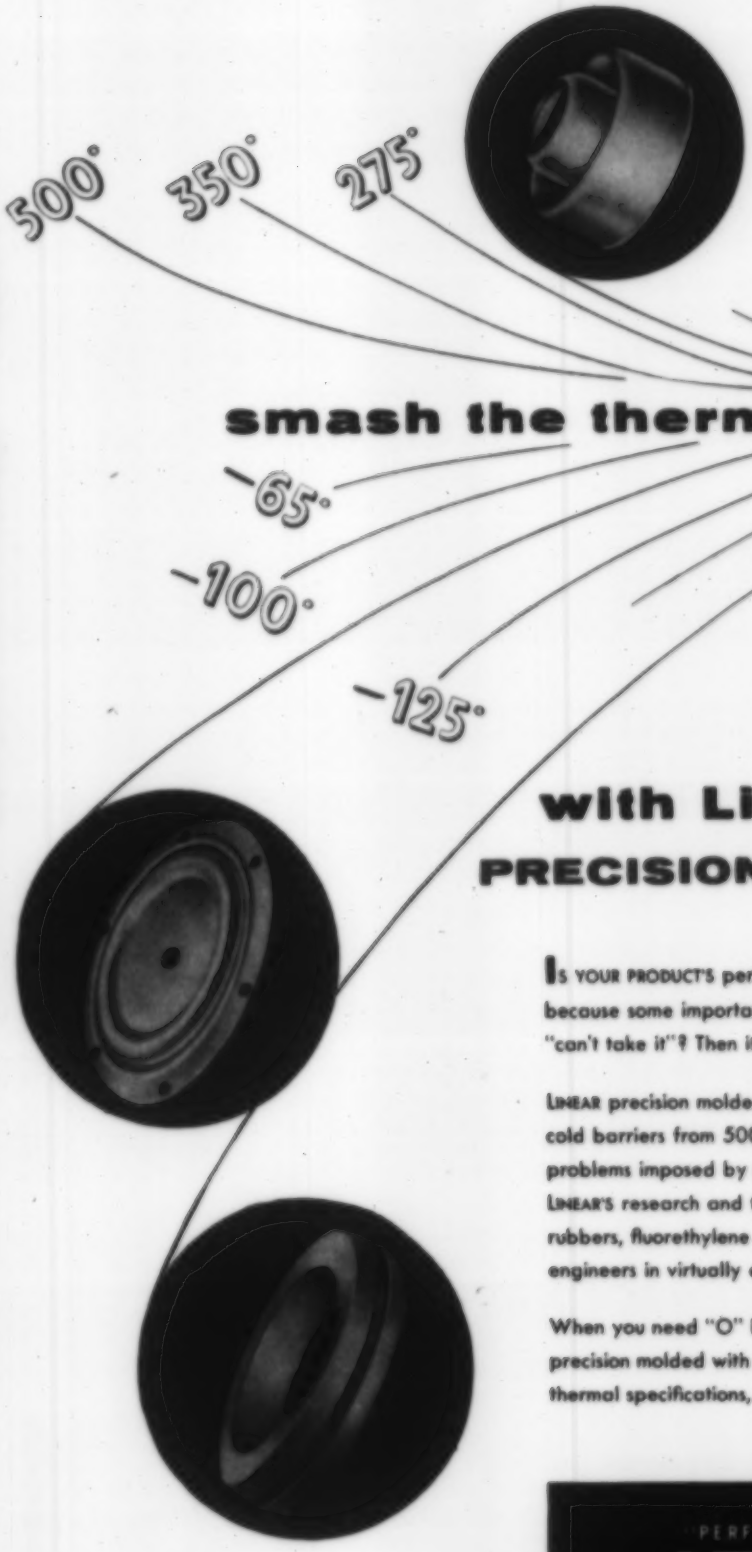
Standard FLEXLOCS lock securely on bolts varying in diameter tolerances. The all-metal, resilient locking sections of the nut accommodate themselves to the diameter tolerances.

Standard FLEXLOCS are one piece, all metal. They are not affected by temperatures to 550°F. Nuts lacking these features have a more restricted temperature range.

Standard FLEXLOCS lock securely—stopped or seated—when 1½ threads of a standard bolt are past the top of the nut.

Standard FLEXLOCS are not affected by moisture, oil, dirt or grit. They lock efficiently under all conditions, regardless of the vibration encountered.

FLEXLOC
LOCKNUT DIVISION
sps
JENKINTOWN PENNSYLVANIA



smash the thermal barrier

with Linear
PRECISION MOLDED PARTS

Is YOUR PRODUCT'S performance limited by a thermal barrier because some important molded rubber component "can't take it"? Then it will pay you to look to LINEAR.

LINEAR precision molded parts are not only overcoming heat and cold barriers from 500° F. to —125° F., but solve design problems imposed by moisture, abrasion and corrosion. LINEAR'S research and testing programs for natural and synthetic rubbers, fluorethylene polymers and silicones are helping engineers in virtually every field of industry.

When you need "O" Rings, Boots, Diaphragms or odd shaped parts, precision molded with exact uniformity, compounded to meet severe thermal specifications, always consult LINEAR in the design stage.

PERFECTLY ENGINEERED PACKINGS

LINEAR

LINEAR Inc. STATE ROAD & LEVICK ST. PHILA 35 PA

(Advertisement)

R B&W FASTENER BRIEFS

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

Technical-ities

By John S. Davey

The Proper Loading of Bolts

The pre-load, or residual tension, in a tightened bolt means more to assembly strength than the actual strength of the bolt itself.

In a joint, a bolt torqued to its proper load level resists a maximum amount of external load without loosening. Designers can take advantage of this fact and assure better results, and at the same time, cut costs.

For example: One designer calculated that truck frames needed high strength bolts at least ½" in diameter. So he used ⅝". But on the assembly line, these were being torqued to 100 ft.-lbs. whereas they needed at least 200 ft.-lbs. for proper residual tension. The ½" bolt at 100 ft.-lbs. would actually have given the stronger assembly and at less cost.

In another case, the bucket on earth moving equipment was always coming loose. The design engineer kept increasing the size of the bolt up to 1¼", but to no avail. The impact wrench used was supplying far too little torque for this size. We suggested a return to the original ¾" bolt used, set up to 350 ft.-lbs. torque. It solved the problem.

In short, the more you stress a bolt within its elastic limit, the greater its ability to stay tight and make a strong assembly.

Symmetrical flow lines assure strong bolt heads

Photo of perfect cold worked blank after first upset.

Effect of improper forming is a poor head like this.

IN THE manufacture of bolts and cap screws, the first upset of metal is a vital one. It determines the flow lines in the bulb which will form the head. A symmetrical flow assures no laps and, therefore, no weak spots or cracks in the final upset of the head.

MACHINE OPERATOR'S SKILL VITAL

The upper photo shows a longitudinal section of a blank after the first upset and on its way to becoming an RB&W standard bolt. Note the even distribution of flow lines. This bulb will become a perfect head.

The lower photo shows what can happen with poor tools, inexperienced operators or without precision setup of the cold headers. Note how pronounced is the unbalanced flow pattern which resulted from a bulb with just a minute defect.

DEPENDABLE FASTENERS

Cap screws and bolts also get a bright smooth finish from the right kind of cold forming. But above all, they offer the designer low cost fasteners with sound internal structure. Standard RB&W fasteners can be loaded to their proper level—become a strong point in any assembly.

For help on your fastener problem, contact Russell, Burdsall & Ward Bolt and Nut Company. Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

The Only Screw That Stays Tight

The continual heating and cooling caused loosening of handle screws on the flat irons of one manufacturer. Every type tried failed to stay tight until RB&W's unique Spin-Lock tapping screws were used. This solved the problem. Their hardened teeth lock into the surface, require more torque to loosen than to tighten. One piece fasteners, they speed assembly time.

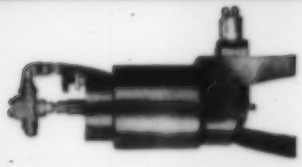
ELECTRONICALLY CONTROLLED hydraulic power FOR AUTOMATION

When Champlain Company, Inc., developed their amazing REGISTRON for *automatic* color register control on rotary presses, they needed a fluid motor that was *precise*. After exhaustive testing of many types, only Eastern Fluid Motors met their high standard for performance.

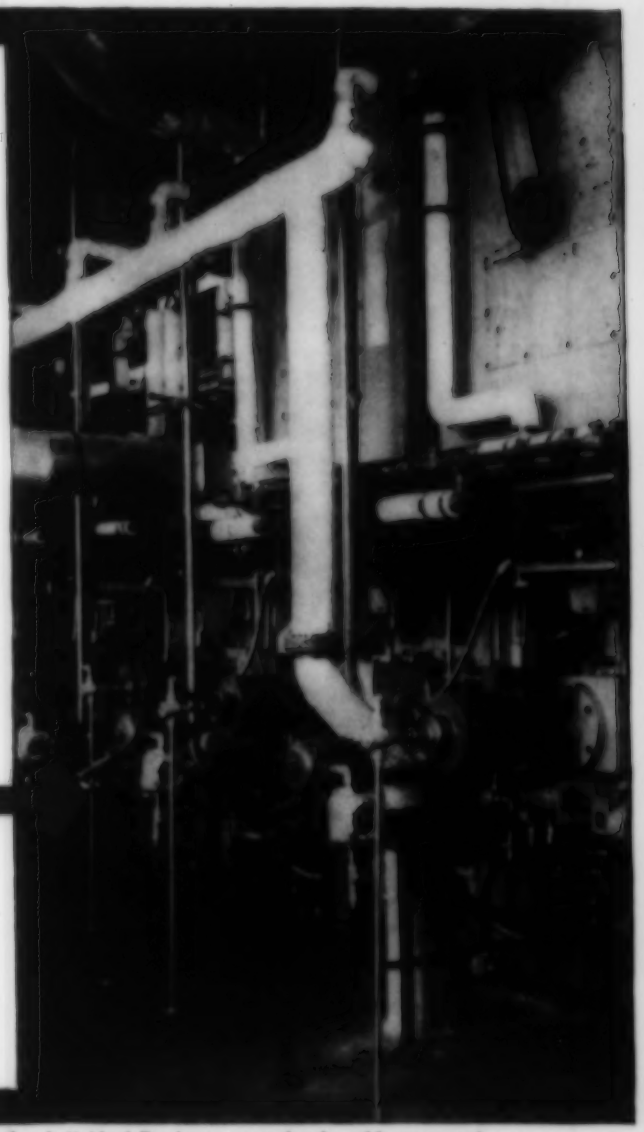
Eastern Fluid Motors are lighter, more compact, and give rapid response because small components give low inertia loads. They quickly transform electronic signals into smooth flowing, precise hydraulic power.

Registrons are installed on high-speed rotary presses that simultaneously print as many as eight colors on a web of paper that travels at speeds up to 1500 feet per minute. Each color must be perfectly registered to tolerance of .0025" or printing appears fuzzy. The Champlain Registron inspects the moving web and the rotating printing cylinder, predicts the occurrence and direction of an off-register condition, and starts and completes a correction quickly.

Eastern is proud to have a part in Champlain's Registron which has developed *automation* in answer to printing's toughest problem.

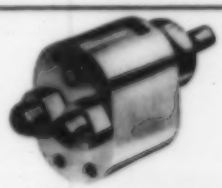


Close up of a phase detector with Eastern Fluid Motor atop it. The fluid motor supplies instant power to move the printing cylinder and correct off-registration within a tolerance of .0025".



Rear view of 8-color, 36" rotogravure press showing individual Registron control units cable-connected to their respective phase detectors. A second cable carries impulses to the units from each web scanner.

HYDRAULIC PUMPS



FLUID MOTORS

AIRCRAFT-TYPE PUMPS

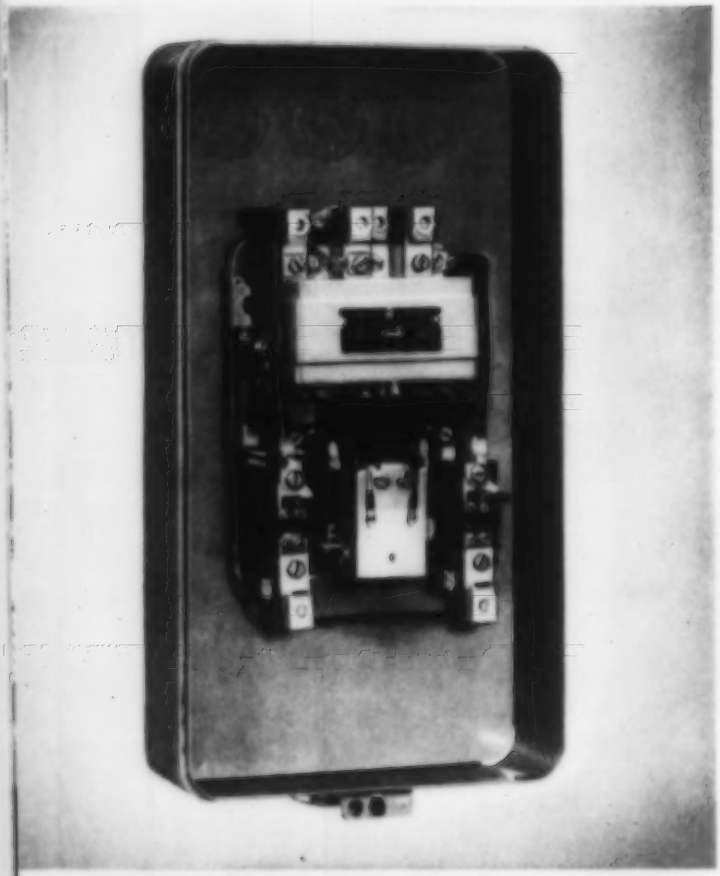
If your application calls for precision hydraulic equipment that performs within strict tolerances, Eastern equipment may provide your best answer. For helpful operating data on fluid motors, hydraulic pumps, and aircraft-type pumps, request catalog series 33.

Eastern

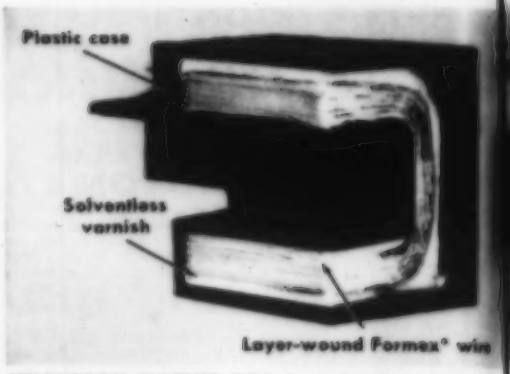
EASTERN INDUSTRIES, INC.

100 SKIFF ST., HAMDEN 14, CONN.

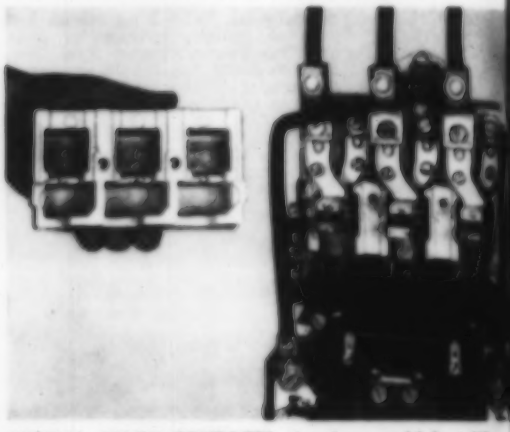
NEW G-E SIZE 4 STARTER



NEW SIZE 4 STARTER is designed for full-voltage starting of squirrel-cage motors. Bi-metallic overload relays may be easily changed from manual to automatic reset without removing from case.

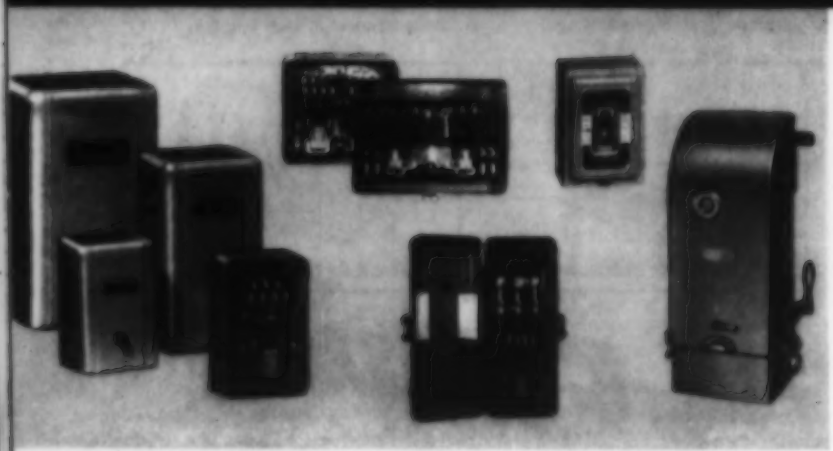


STRONGBOX MAGNET COIL is enclosed in a tough molded plastic case. Coil has firmly anchored terminals and is protected against dirt, oil and moisture.



SPECIAL ALLOY CONTACTS give long weld-free life. Arcs are quickly extinguished by new blow-out design of contacts and cooling action of grids.

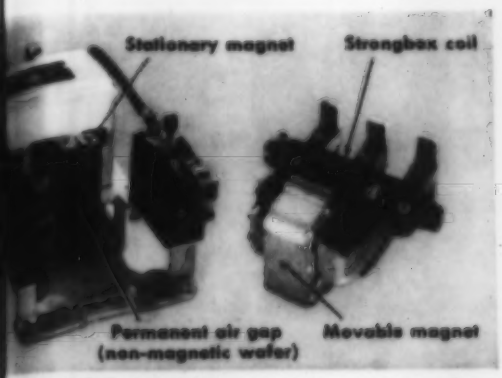
CHOOSE FROM THE COMPLETE LINE



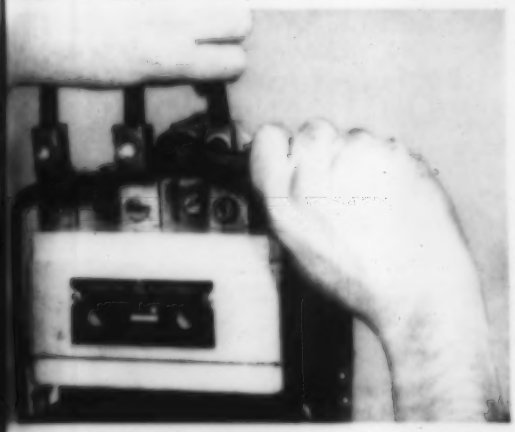
THOUSANDS OF STARTERS are available. They include: combination, reversing, multispeed, and manual and magnetic starters for full- or reduced-voltage starting. Starters are available in all popular NEMA and special enclosures.

PUSH BUTTONS are furnished for standard, heavy-duty, or oiltight applications. Stations come in all NEMA enclosures.

FOR 25- TO 100-HP MOTORS



PERMANENT AIR GAP, away from striking surfaces, can't wear down and cause starter to "stick-in." Magnet design prevents contact chatter.



FRONT WIRED AND MOUNTED, new starter has solderless, pressure-type terminals for wires from AWG No. 6 to 250,000 c.m. 3-point front mounting is easy.

New magnetic starter for squirrel-cage motors

General Electric now adds a new, compact, NEMA Size 4 starter to its complete line of magnetic starters. The new starter offers many customer-proved features of size 0 to 3 G-E magnetic starters, such as the strongbox coil and the permanent air gap.

INSTALLED FROM THE FRONT, the new starter has 3-point mounting, and is completely accessible from the front when mounted. Right up in front are the solderless, pressure-type terminals for easy wiring. Also, 3 electrical interlocks, in any combination, can be installed from the front without removing the arc chute or movable-contact assembly. A vertical or horizontal mechanical interlock is also available for reversing and multispeed controllers.

MAINTENANCE IS EASY, and a screwdriver is the only tool required. Contacts are readily changed, and both coil and contacts are removable from the front without disturbing power wiring.

FOR MORE INFORMATION, contact your nearest G-E Apparatus Sales Office or Distributor, or mail in the coupon below. Ask for Bulletin GEA-6322.

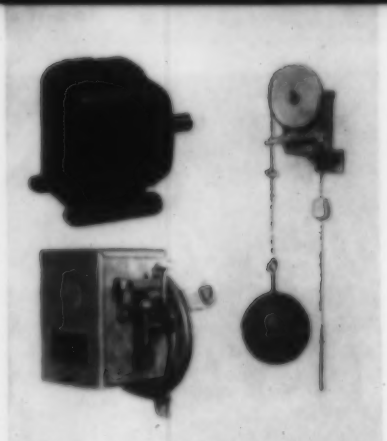
*Reg. Trade-mark General Electric Co.

Progress Is Our Most Important Product

GENERAL ELECTRIC

OF G-E CONTROL DEVICES

LIMIT SWITCHES AND SOLENOIDS include lever and cam type limit switches, and the new strongbox solenoid.



G.E.'s LINE OF SWITCHES include pressure, vacuum, float, plugging and anti-plugging, pilot and reversing switches.

FREE NEW CATALOG of G-E General Purpose Controls.

Advertising and Sales Promotion Sect. G 734-2
General Purpose Control Department
General Electric Company
Bloomington, Illinois

Please send a free copy of:

- ☐ GEC-1260A New Control Catalog
- ☐ GEA-6322 New Size 4 Starter
- ☐ For reference ☐ For immediate project

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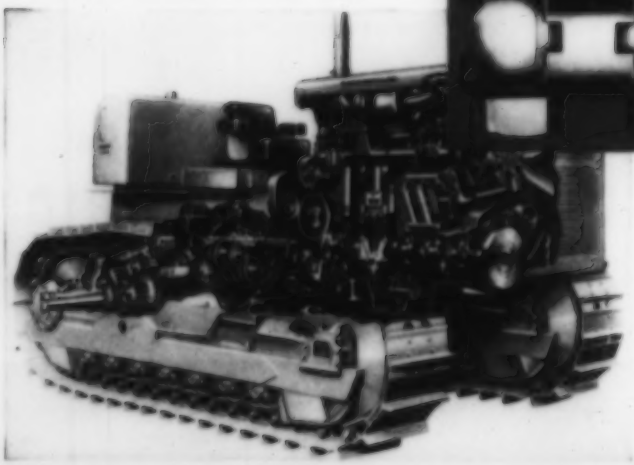
Company.....
Address.....
City..... State.....

BEHEMOTH

All of the world's "biggest" tractors depend on MECHANICS Roller Bearing UNIVERSAL JOINTS to compensate for heavy-duty shocks and strains — severe enough to twist tractor frames. MECHANICS key-drive strength, flexibility and balance are unanimously specified by the largest tractor manufacturers to keep huge capacity machines operating long hours, day-after-day. They

Thoroughly field tested during 1954, when Caterpillar put ten D9Xs on various jobs from coast to coast. This 56,000-pound machine has many earthmoving, construction, logging and pipe laying applications.

The Cat D9 Tractor, shown below, sixth machine in Caterpillar's crawler line, is a 230-drawbar horsepower turbocharged tractor resulting from 10 years of big tractor research and development.



can't afford to permit large tractors and equipment to be kept idle by needless down-time. Let MECHANICS engineers help build reliability into your (200 to 50,000 foot pounds torque capacity) machines.

MECHANICS UNIVERSAL JOINT DIVISION
Borg-Warner • 2032 Harrison Ave., Rockford, Ill.

MECHANICS

Roller Bearing BW

UNIVERSAL JOINTS

For Cars • Trucks • Tractors • Farm Implements • Road Machinery • Aircraft • Tanks • Busses and Industrial Equipment

KLOZURE* OIL SEALS

protect the pitch bearings on Piasecki's newest helicopters

KLOZURE Finger Spring Model 53 with silicone sealing element and felt washer.

In designing the pitch bearing assembly of the new H-21 cargo and troop transport helicopter, Piasecki engineers needed a dependable oil seal which would protect the needle bearings in this assembly under the most severe flight conditions . . . at temperatures ranging from −65°F. to +160°F.

After exhaustive tests, Piasecki engineers selected our finger spring KLOZURE Model 53 with silicone sealing element and felt washer. This superior oil seal gave *positive* bearing protection under *all* operating conditions—dust and contaminants were sealed out, the lubricant was sealed in.

Let us show you how Garlock KLOZURES can solve your sealing problems. There's a proven KLOZURE model for every bearing application. For complete information, contact the Garlock office nearest you or write for KLOZURE Catalog 10.

THE GARLOCK PACKING COMPANY, PALMYRA, N. Y.

Sales Offices and Warehouses: Baltimore • Birmingham • Boston • Buffalo • Chicago Cincinnati • Cleveland • Denver • Detroit • Houston • Los Angeles • New Orleans • New York City • Palmyra (N.Y.) • Philadelphia • Pittsburgh • Portland (Oregon) • Salt Lake City • San Francisco • St. Louis • Seattle • Spokane • Tulsa.

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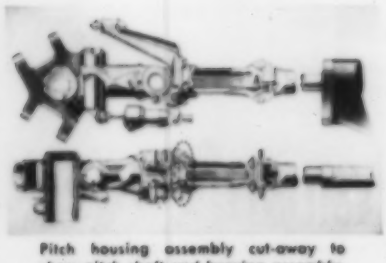
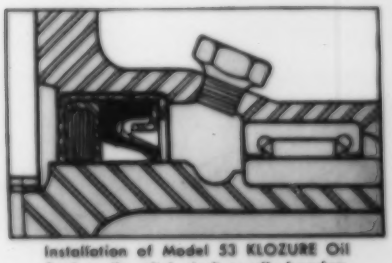
GARLOCK

*Registered Trademark

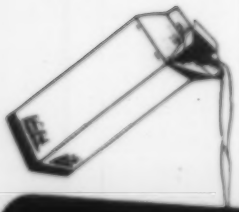
Complete rotor hub assembly for H-21 helicopter showing 3 pitch housing assemblies.



Pitch housing assembly cut-away to show pitch shaft and bearing assembly.



Installation of Model 53 KLOZURE Oil Seal on the pitch shaft needle bearing.



New Milk Packaging Machine Fabricates, Sterilizes, Fills and Seals

75 Cartons per minute!

DIAMOND
CONVEYOR CHAINS

assure coordination of operations and outstanding dependability on EX-CELL-O's® Pure-Pak Machine

Coating unit conveyor chain consists of bent lug attachment plates and outboard rollers mounted both sides on extended pins.

Below: Pure-Pak Model Q Machine

● The new Pure-Pak carton snaps open quickly forming a pitcher-like spout that makes pouring easy and prevents spilling.

To make this carton, Ex-Cell-O developed completely new machines. The Model Q is the quart, pint or half-pint machine that turns out 75 cartons per minute. Handling that many cartons from flat, uncoated stock to finished, filled cartons demands precise timing, positive conveying and the utmost dependability.

Diamond Conveyor and Roller Chains can be the answer to your machinery and materials handling problems. Many attachment plates are standard and in stock. Special attachments made from various metals can be made to order. Diamond Engineers are ready and able to help you *now*.

Catalog 34 contains specifications and engineering data. Write for your copy today.

Diamond Conveyor Chain with special lugs for handling assembled cartons.

ALWAYS PRELOADED

For many, many years, Diamond Chain has been preloaded after assembly for the purpose of bringing pin-bushing seating into stabilized relationship prior to field installation.

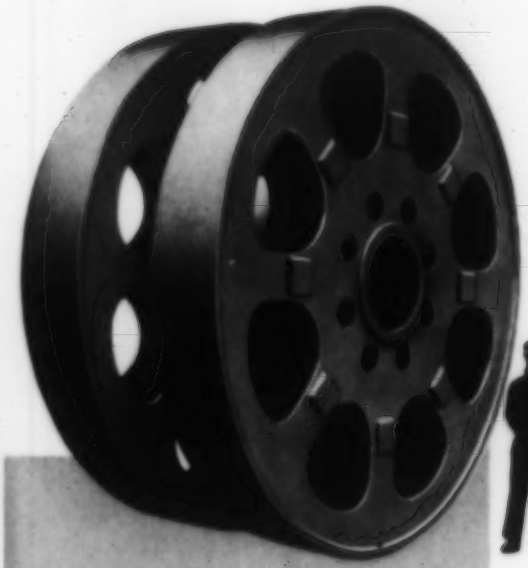
DIAMOND CHAIN COMPANY, Inc.

Where High Quality is Traditional

Dept. 435, 402 Kentucky Avenue, Indianapolis 7, Indiana

Offices and Distributors in All Principal Cities

DIAMOND ROLLER CHAINS



When you need LARGE—HEAVY and ACCURATE Weldments call on STRUTHERS WELLS

Twin Turbine Gear Wheel for Westinghouse Electric Corporation

Of heavy steel throughout with a hollow bored steel hub made in our own forge plant.

Column Bearing Plates for Loewy-Hydropress, Incorporated, N.Y.C.

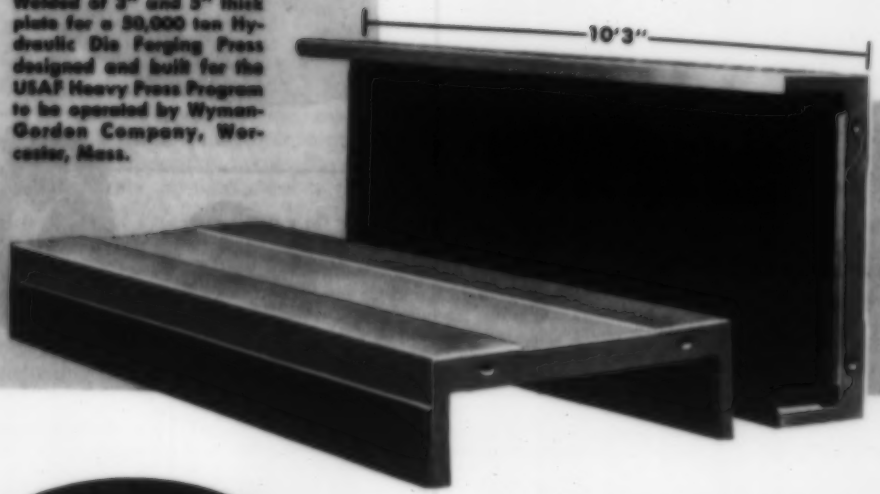
Welded of 3" and 5" thick plate for a 50,000 ton Hydraulic Die Forging Press designed and built for the USAF Heavy Press Program to be operated by Wyman-Gordon Company, Worcester, Mass.

The Gear Wheel and Bearing Plates illustrated typify Struthers Wells' manufacturing versatility.

The extensive facilities of three modern plants plus a century of experience are at your service.

We welcome the opportunity of furnishing either the complete assembly or any weldment part that is beyond your capacity.

Write for Weldments bulletin.



Forty of these 8900 lb. bearing plates were supplied for the 50,000 ton Hydraulic Die Forging Press. Dimensions were 45" wide x 15" high x 10'3" long.

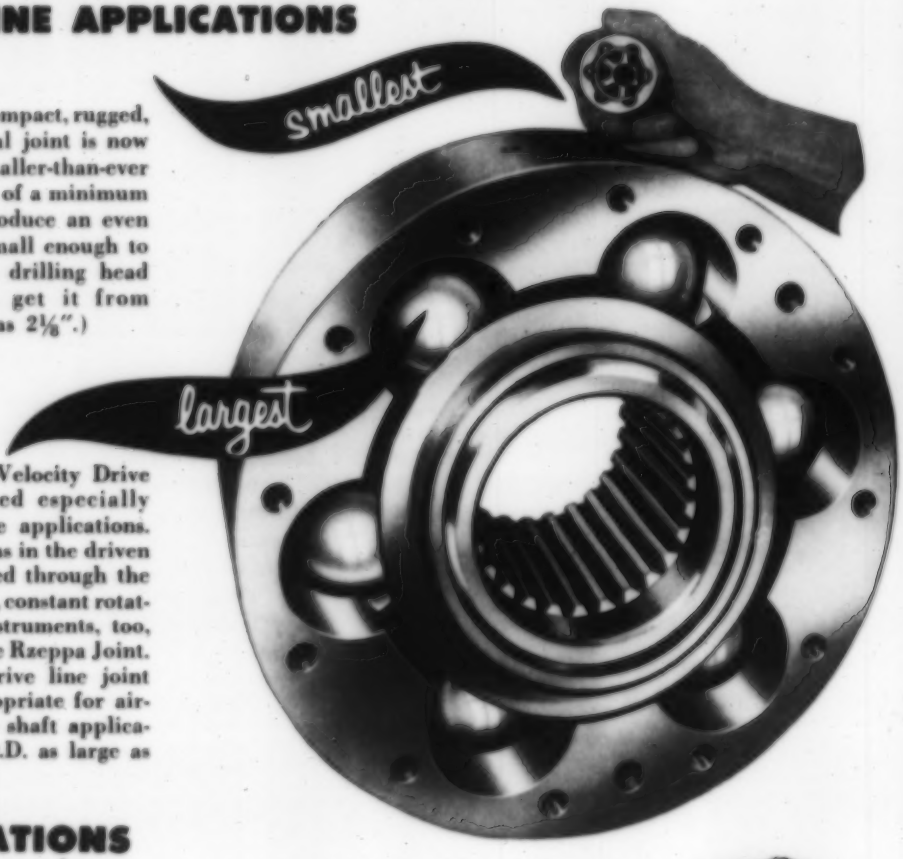
Struthers Wells

STRUTHERS WELLS CORPORATION
Titusville, Pennsylvania
Plants at Titusville, Pa. and Warren, Pa.

What's New in Constant Velocity UNIVERSAL JOINTS

FOR DRIVE LINE APPLICATIONS

Industry's demand for a compact, rugged, constant velocity universal joint is now being serviced with the smaller-than-ever Rzeppa. If you have need of a minimum weight joint that will produce an even flow of power—a joint small enough to be suitable for machine drilling head applications—you can get it from Rzeppa. (O.D. as small as 2⅛".)



Large Rzeppa Constant Velocity Drive Line Joints have proved especially capable on 4-wheel drive applications. Speed fluctuation problems in the driven shaft have been eliminated through the patented principle of true, constant rotating motion. Precision instruments, too, are making use of the large Rzeppa Joint. Should you require a drive line joint large enough to be appropriate for aircraft dynamometer drive shaft application, look to Rzeppa. (O.D. as large as 16".)

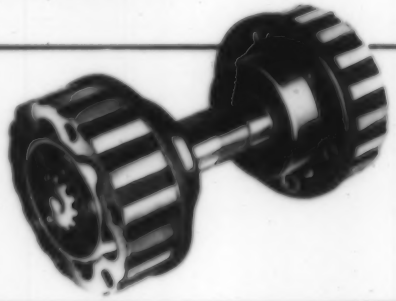
NEW APPLICATIONS

High angle efficiency, ruggedness, high capacity, and long life are among the reasons why Rzeppa Constant Velocity Joints are on the move. From the smallest to the largest they are being used on the drive lines of:

- Machine Tools
- Road Building Equipment
- Mining Equipment
- Steel Mill Equipment
- Oil Field Equipment
- Testing Instruments

TYPICAL DRIVE LINE APPLICATION:

Jointed shaft for independently sprung rear drive axle and propeller shafts for industrial applications. Solid or tubular shaft.



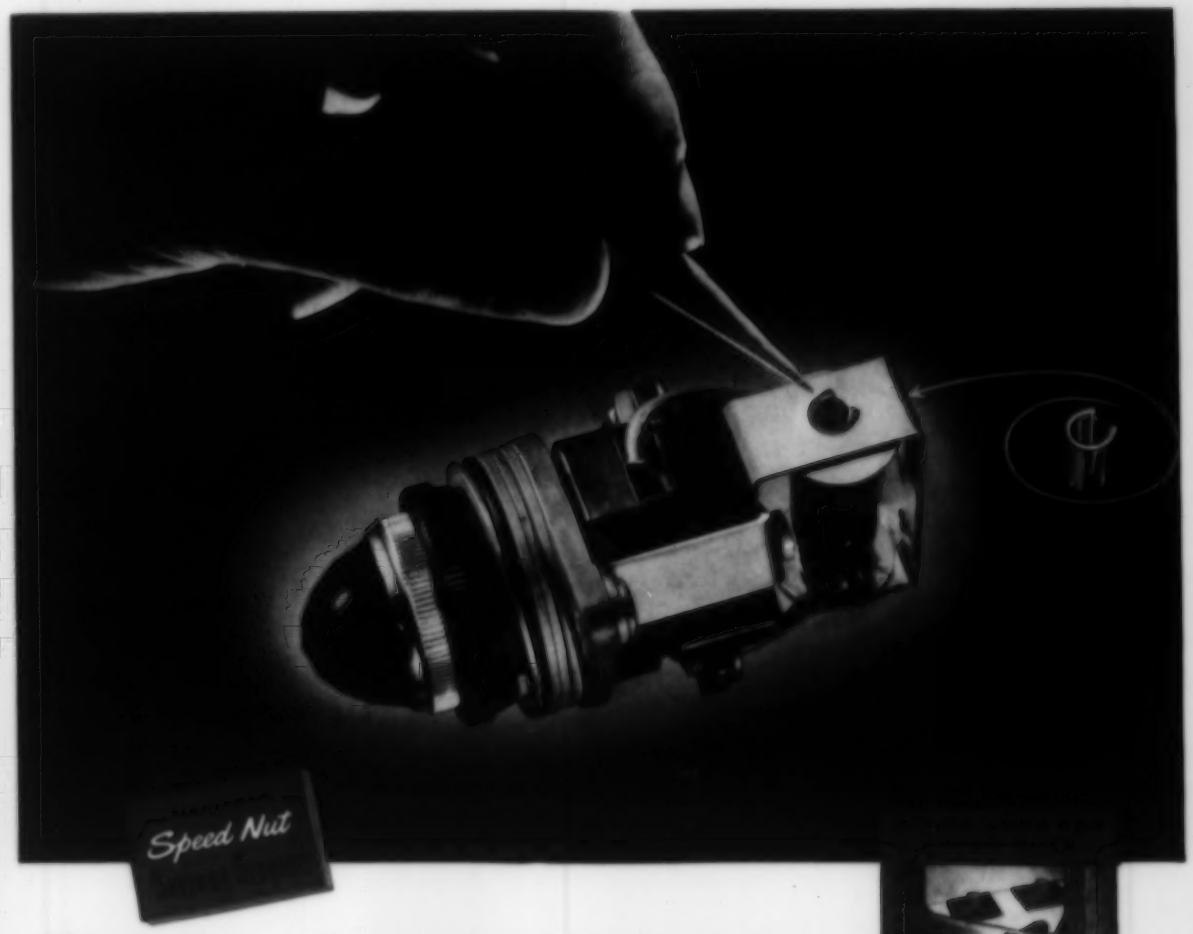
RZEPPA Constant Velocity UNIVERSAL JOINTS

E-4

For complete Rzeppa performance and engineering story—send for this catalog now.

The Gear Grinding Machine Company

3937 Christopher • Detroit 11, Michigan



Time-saver, space-saver, money-saver ...Tinnerman tubular SPEED CLIP®!

Here's how the General Electric Company is keeping costs and space requirements low on its G-E oiltight Indicating Lights. They use Tinnerman tubular-type SPEED CLIPS to assemble the resistor to its support. This one-piece, spring-steel fastener reduces assembly time, material costs, parts handling and inventory by eliminating a long bolt, centering washer, lock washer and nut. It also reduces the dimension across the resistor support and saves valuable space when the lights are used close to pushbuttons and other components.

A wide variety of types and sizes of tubular-type SPEED CLIPS are used on everything from toys to autos—on metal, plastic or wood. They snap into punched or molded holes by hand; are self-retained in stud-receiving position. SPEED CLIPS are also ideal for blind attachments where only one side of an assembly is accessible.

Possibly Tinnerman SPEED NUT brand fasteners can help you improve your present fastening methods. See your Tinnerman representative soon and write for your copy of "SPEED NUT Savings Stories".

TINNERMAN PRODUCTS, INC. • BOX 6688, DEPT. 12, CLEVELAND 1, OHIO

Canada: Dominion Fasteners, Limited, Hamilton, Ontario. *Great Britain*: Simmonds Aerocessories, Limited, Treforest, Wales. *France*: Aerocessoires Simmonds, S. A., 7 rue Henri Barbusse, Levallois (Seine). *Germany*: Hans Sickinger GmbH "MECANO", Lemgo-i-Lippe.

TINNERMAN Speed Nuts®

FASTEST THING IN FASTENINGS®

Tubular SPEED CLIPS save 51% in time, 34% in cost, assembling Drive-In auto speakers.

Push-On SPEED NUTS save 50% in assembly of rotating TV-antenna control box.

"J" and "U" type SPEED NUTS help gain 50% assembly saving on jet-convector heater.

SAFEGUARDING INDUSTRY'S *Lifelines of Mobile Power*

MODERN INDUSTRY MOVES WITH HYDRAULIC POWER

delivered through

Eastman

HYDRAULIC HOSE ASSEMBLIES

EASTMAN — *first in the field* of Hydraulic Hose Assemblies—has had the privilege of *pioneering* in many original applications of hydraulic power — on equipment made by many of America's leading manufacturers — as shown in action in the industries, above.

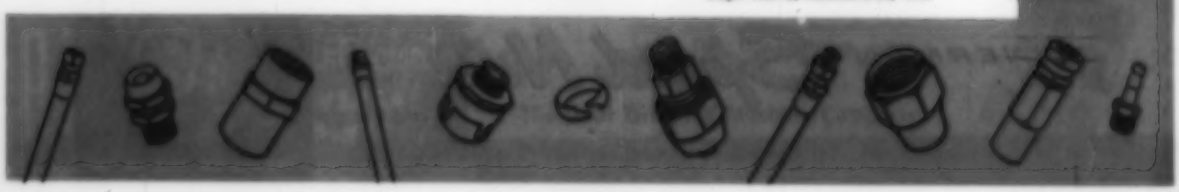
Modern industry not only moves *hydraulically*, but with increased efficiency and economy—with improved production and performance . . . the kind of performance that improves your competitive position in your field.

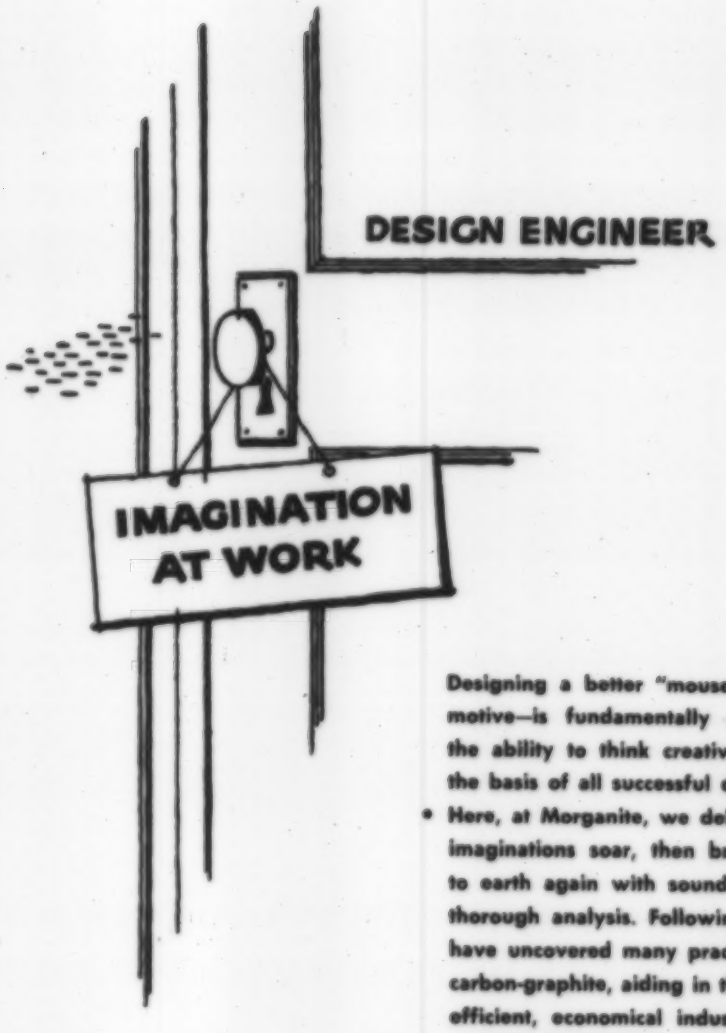
If you have a power transmission problem, consult with Eastman Engineers. For improved performance due to many original exclusive Eastman designs . . . for quality of material and workmanship—always specify Eastman Hydraulic Hose Assemblies.

Eastman
first in the field
MANUFACTURING COMPANY
Dept. MD-8, Manitowoc, Wis.

FREE

WRITE for free Catalog 101 on Eastman Hose Assemblies.





Designing a better "mouse-trap"—or a locomotive—is fundamentally a mental process, the ability to think creatively. This is the basis of all successful design engineering.

- Here, at Morganite, we deliberately let our imaginations soar, then bring them back to earth again with sound judgment and thorough analysis. Following this practice we have uncovered many practical uses for carbon-graphite, aiding in the design of highly efficient, economical industrial equipment and household appliances.
- Carbon-graphite is an inert material resistant to most acids, unaffected by changing temperatures. It is light in weight and will retain it's strength and hardness under extreme temperature conditions. It is self-lubricating, an excellent material for bearings, seals, valves, piston rings, pump vanes and a host of other parts.
- We will welcome an opportunity to work with you. Perhaps together we can solve the "unsolvable." Simply write us, stating your problem. Our technical staff will take it from there.

Morganite INCORPORATED

MORGANITE INCORPORATED • 3302-3320 48TH AVENUE • LONG ISLAND CITY 1, NEW YORK

This Steel keeps these outdoor phone

Republic Electro Paintlok

Year-round weather is mighty rough on outdoor phone booths. To make them practical from a maintenance standpoint, as well as continually attractive, a durable, long-lasting finish is a must.

That's why the Sherron Metallic Corporation of Brooklyn, New York, chose Republic Electro Paintlok for its popular all-metal outdoor booths.

Electro Paintlok is the zinc-plated steel sheet that is chemically treated to take paints, lacquers, synthetic enamels—and hold them in a tight grip for years, even under hard service and severe exposure.

Furthermore, only minimum maintenance is required. Should the painted surface become scratched, the tight zinc coating protects against underfilm corrosion and

REPUBLIC

World's Widest Range of Standard

REPUBLIC STEEL

REPUBLIC STEEL CORPORATION
3130 East 45th Street • Cleveland 27, Ohio

Please send me more information on:

- ☐ Republic Electro Paintlok
- ☐ Republic Stainless Steel
- ☐ Republic Titanium
- ☐ Republic Mechanical Tubing

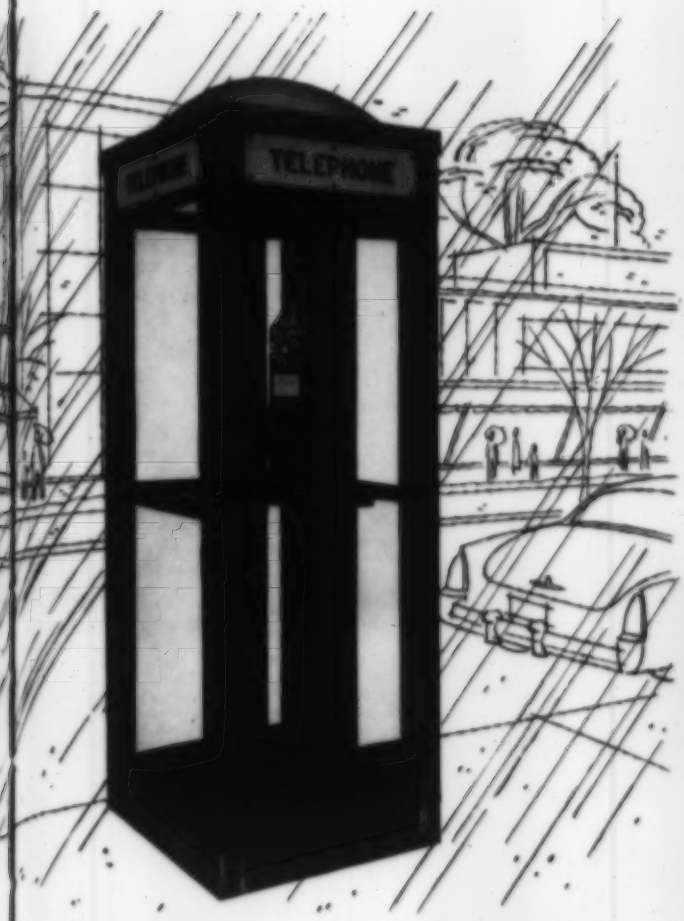
Name_____ Title_____

Company_____

Address_____

City_____ Zone_____ State_____

K-6808A



booths color-bright

provides lasting paint adherence

creeping rust that would eventually cause trouble.

Republic Electro Paintlok is easy to fabricate, too. The well-bonded zinc coating will not fracture during fabricating, will not crack, peel or flake when punched or sheared.

The entire finishing operation is speeded because Electro Paintlok requires no special cleaning. A water-soluble cleaner will quickly remove fingermarks and warehouse dirt. And since surfaces are pre-conditioned, no pre-etching is required.

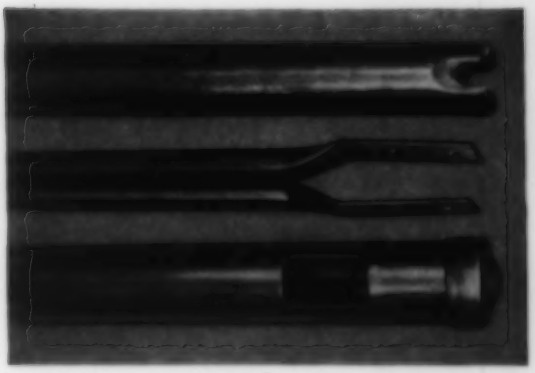
If you want your painted or enameled steel products to look better longer, get the complete facts on Republic Electro Paintlok. Send coupon for Republic Book 525.

STEEL

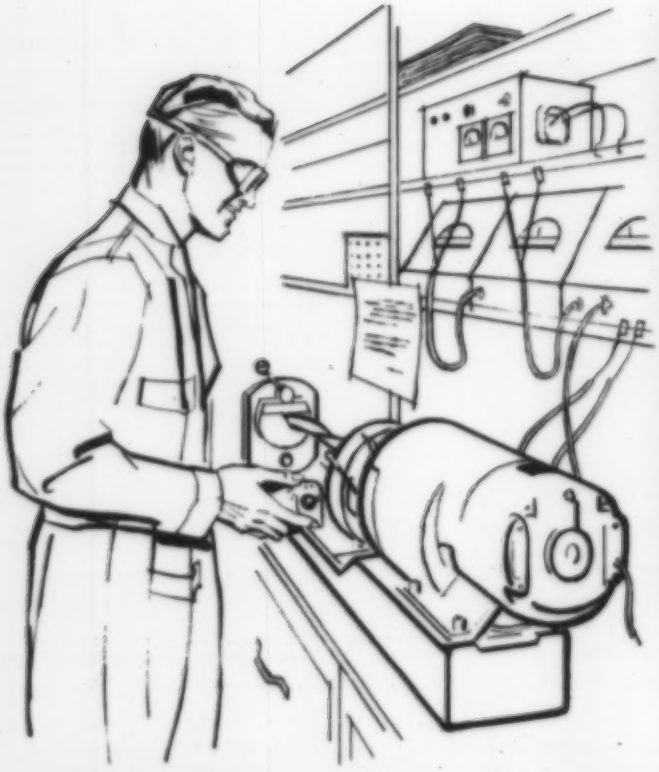
Steels and Steel Products

ENDURO STAINLESS STEEL DOES MANY JOBS EFFICIENTLY AND ECONOMICALLY. Here ENDURO, produced at Republic's Alloy Division, is used in a bellows that goes between a jet engine and exhaust tubes because of its heat-resistance and ability to expand and contract uniformly. There are other advantages—such as increased structural strength without added weight. Corrosion-resistance. High physical and chemical properties. Republic metallurgists will help you use ENDURO to best advantage.

TITANIUM PARTS CAN BE MACHINED like parts made from many other metals. This part is being hogged out of a titanium forging at Cleveland Pneumatic Tool Co. It will then be turned, drilled, reamed, ground, tapped, and threaded. Republic metallurgists recommend metals without prejudice. They will tell you whether titanium can be adapted to your product—will help you use it to advantage. Republic produces titanium and titanium alloys in hot and cold rolled bars, sheets, plates and billets at its Alloy Division.



IF YOUR PRODUCT INCLUDES TUBULAR PARTS, you can save an investment in new equipment by letting Republic produce them. Its Steel and Tubes Division has complete facilities for handling all kinds of tough fabricating jobs—like bending, broaching, coiling, configuring, expanding, flattening, grooving, notching, upsetting, tapering—to name just a few. For precision on a production basis—that will lower your fabricating costs—call Republic. Send coupon.



Enameling iron, with 1 coat of porcelain enamel over Parker Pre-Namel 410, was twisted 255° before enamel fractured.

Enameling iron, with conventional 2-coat system of porcelain enamel, fractured badly when twisted only 70°. (Twisted less than its elastic limit, metal returned to its original shape).

NEWS OF A REVOLUTION

that's about to happen!

Porcelain enameling on steel has always been a preferred finish. However, its use has been limited by cost and by difficulties in the processing.

Now, a big change is about to take place. It is coming about through a cooperative effort that we feel should be acknowledged.

First, Parker Rust Proof Company's research discovered and developed a surface treatment for steel which permits the application of the porcelain enamel finish coat directly to ferrous metals, reduces cost, improves quality and eliminates many production difficulties in porcelain enameling. For production evaluation, Frigidaire Division of General Motors and Pemco Corporation entered the effort with pilot runs and production tests.

The new treatment, making use of Parker Pre-Namel 410, has been shown to simplify porcelain enameling, achieve high quality uniform results, reduce use of frit, produce a more durable finish. Savings of from 1 to 3 cents per square foot of enameling surface are indicated.

We gratefully acknowledge the help we've had from Frigidaire and Pemco. Here is another instance of companies in diverse lines cooperating in a development program today which should benefit hundreds of manufacturers and millions of their customers in the future.

**Bonderite, Bonderlube, Parco, Parco Lubrite, Parker Pre-Namel—Reg. U.S. Pat. Off.*

Since 1915—Leader in the Field

1915 40th year 1955

PARKER RUST PROOF COMPANY

2193 E. Milwaukee, Detroit 11, Michigan

BONDERITE	BONDERITE and BONDERLUBE	PARCO COMPOUND	PARCO LUBRITE	TROPICAL
corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces	heavy duty maintenance paints since 1883

OHMITE® HIGH CURRENT ROTARY TAP SWITCHES

For your AC power-switching requirements in the 10 to 100 amp range, Ohmite Tap Switches are the finest units available. They are load-break, non-shorting, single-pole switches of unusually compact design.

Numerous design and construction features provide ruggedness and dependability. Silver-to-silver contacts eliminate contact maintenance. The rotor contact is self-cleaning. The switch shaft is electrically "dead"—insulated by a strong ceramic hub. Furthermore, the positive cam-and-roller mechanism for "slow-break, quick-make" action greatly increases contact life.

Ohmite Tap Switches are available with 2 to 12 taps in the single pole, non-shorting type. Two or three switches can be grouped in tandem to form multi-pole assemblies. They are also available in open-type models for both shorting and non-shorting applications.

Write on Company Letterhead for Catalog and Engineering Manual No. 40

OHMITE MANUFACTURING COMPANY
3618 Howard Street, Skokie, Illinois (Suburb of Chicago)

ALL CERAMIC AND METAL

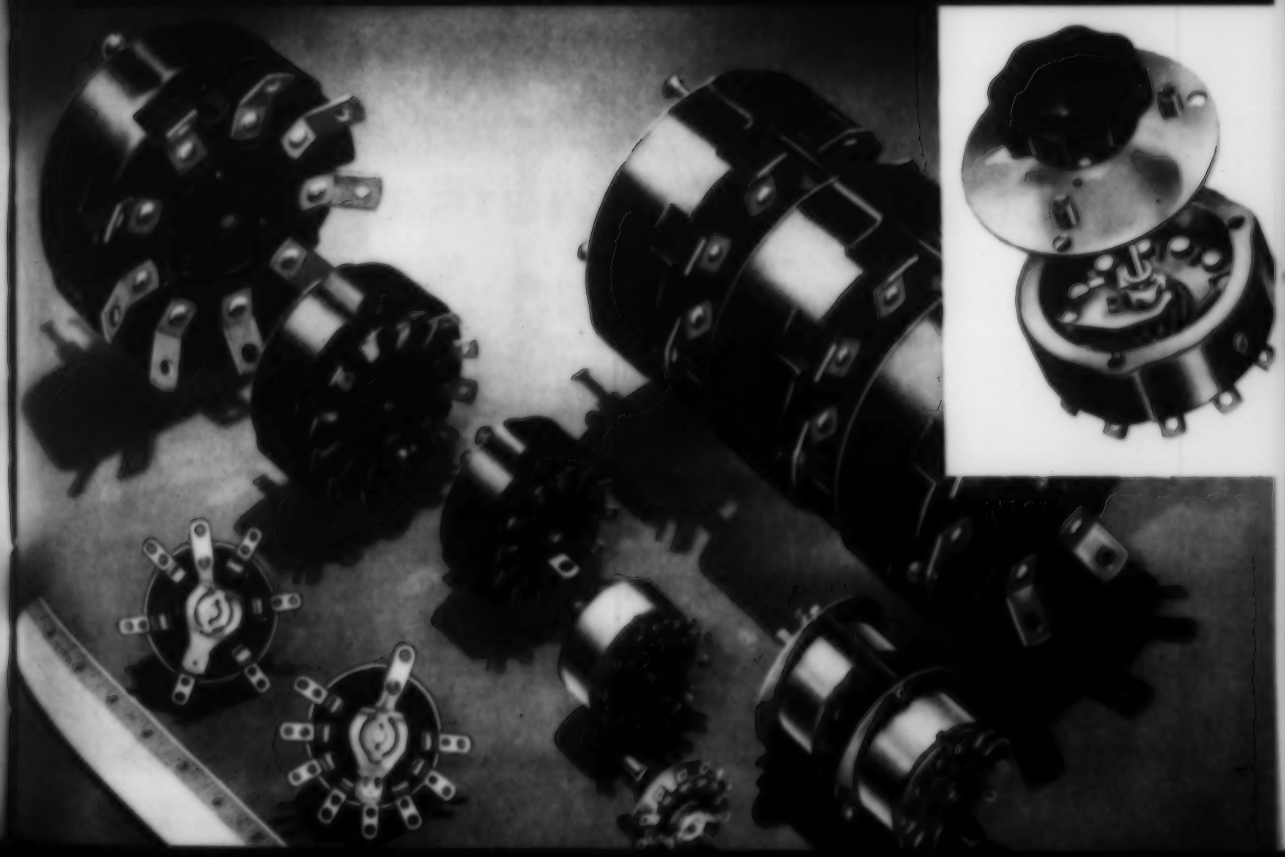
•

NOTHING TO BURN OR CHAR

•

FIVE SIZES—10, 15, 25, 50, AND 100 AMPS

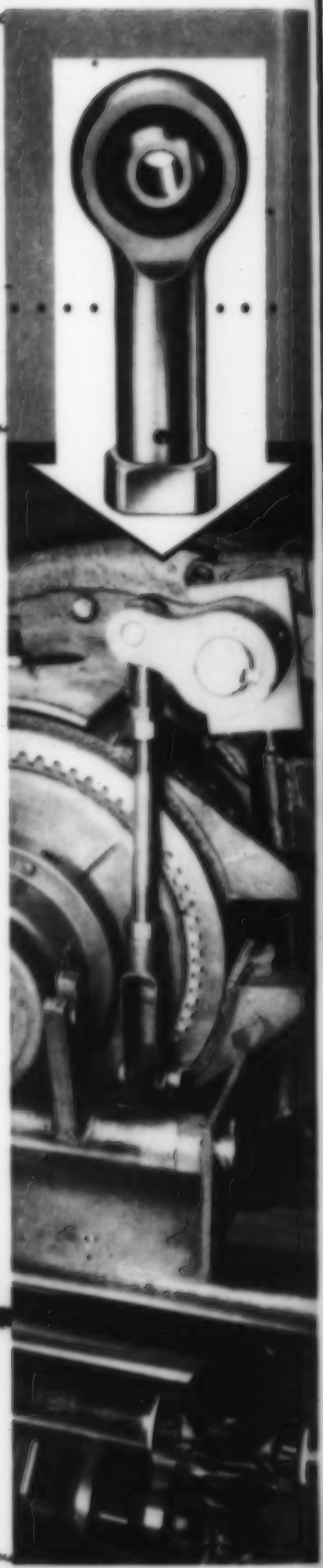
OHMITE RHEOSTATS · RESISTORS · RELAYS · TAP SWITCHES



Compressed Air Clutch

operated by . . . . .

HEIM *Unibal* ROD END . . . . . .



On the Joy Champion Blast Hole Drill, there is a compressed air operated clutch which is used for tramming a machine with special wide crawler treads used on the soft ground in strip mines operations. A heavy duty, self-aligning HEIM Rod End transmits the motion through the linkage operating this clutch.

Why Use HEIM?

When power or motion must be transmitted at odd or varying angles, some form of universal joint must be used. Heim Rod Ends, with their single Unibal principle, reduce friction, correct misalignment, carry maximum radial and thrust loads, and cost less than specially made connections.

Whether your product perches on the brink of a strip mine or is one of the thousands of contemporary tools and machines, you probably have a place where a Heim Rod End can save you money or deliver smoother, longer-lasting service. You should at least have the new Heim catalog at hand.

THE HEIM COMPANY
FAIRFIELD, CONNECTICUT

THESE FEATURES IMPROVE PRESS PERFORMANCE:
• serves as both rotating air-seal and timing device
• compact design saves shaft space
• completely sealed and self-contained
• provides simple cycle adjustment
• convenient to install and service
• simplified mounting
• may be adapted to existing equipment
• operates at speeds to 800 R. P. M.
new,
unique
Timing Rotorseal gives...
FAWICK
TIMING
ROTORSEAL

better, safer press operation

Improved operation and safety are but two of the many advantages the new FAWICK Airflex Timing Rotorseal can give your presses and machine tool equipment. By combining functions of a rotary air-seal and cycle-timer into a single unit, FAWICK has produced a compact device which provides efficient control of air pressure to clutch and brake at a pre-set interval. Hazardous open cam limit switches, sprockets and timing chains are eliminated—maintenance costs are reduced.

FAWICK Timing Rotorseals are available in individual units or as an integral part of the FAWICK Standardized Press Application, a low-cost kit for converting O.B.I. and straight-side presses from mechanical to pneumatic clutch and brake.

Find out how the FAWICK Timing Rotorseal can cut maintenance and improve the safety and performance of your presses.

See the Timing Rotorseal and other FAWICK products in action at Press Manufacturers' Booths in the Machine Tool Show in Chicago, September 6-17. You are also invited to visit the FAWICK Airflex Booth 215 at the Metalworking Machinery and Equipment Exposition at the Chicago Coliseum, September 6-17.

FAWICK AIRFLEX DIVISION
FAWICK CORPORATION
9919 CLINTON ROAD • CLEVELAND 11, OHIO
IN CANADA: FAWICK CANADA, LTD., TORONTO — MONTREAL

FAWICK Airflex
INDUSTRIAL CLUTCHES AND BRAKES

PRODUCTION *Zooms* 1000 PER CENT

with Mechanized HELIARC Welding

A HELIARC *HW-13 torch is being used to weld a 1/8-in. aluminum radar cover.*

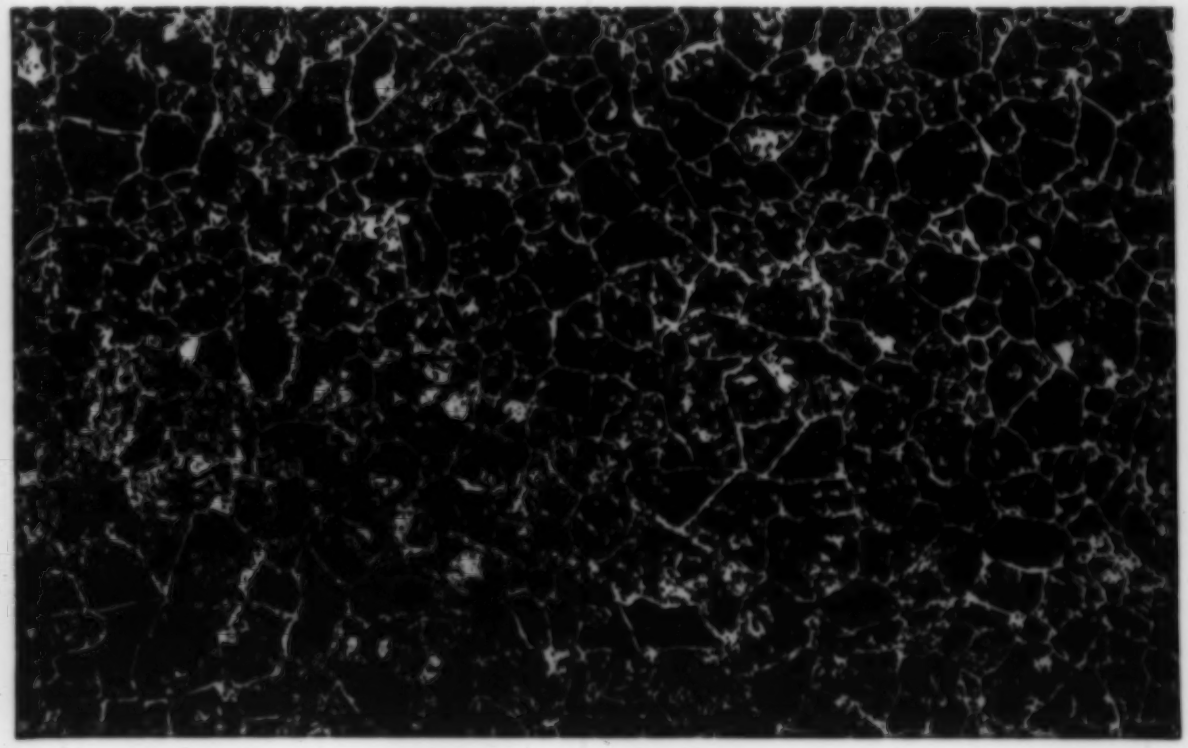
A West Coast aircraft plant is using mechanized HELIARC welding to join the components of aluminum sealing covers for radar units—the "Seeing Eyes" of the Armed Services. Welding time has been cut from one hour and 10 minutes to only six minutes and the plant now turns out eleven covers in the same time it had formerly taken to produce one. Because the HELIARC welds are shielded from contamination by an inert gas, such as argon, they require no flux and are free from porosity and oxide inclusion. This results in fewer rejections and a minimum of finishing.

LINDE's team of welding processes—HELIARC, sigma, and UNIONMELT welding—can help you cut production costs and increase quality. Whatever your welding problem—one of LINDE's electric welding processes can do the job efficiently and economically. Call your local LINDE representative today for more information.

Linde Air Products Company
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street UCC New York 17, N. Y.
Offices in Other Principal Cities
In Canada: LINDE AIR PRODUCTS COMPANY
Division of Union Carbide Canada Limited, Toronto
(formerly Dominion Oxygen Company)

Linde Trade-Mark

"Heliarc," "Unionmelt" and "Linde" are registered trade-marks of Union Carbide and Carbon Corporation.



See for yourself why TIMKEN® forging steels give you uniform, high quality forgings

NOTE the uniform grain size in this photomicrograph of Timken® forging steel. We examine every heat of Timken forging steel—spectrographically to assure uniform grain size. As a result, you can be sure that forgings made from Timken forging steels will give you uniformly high ductility and resistance to impact.

Because your order of Timken forging steel is handled individually in our mill we are able to target our conditioning procedure to your particular forging requirements. That minimizes your rejects.

Every lot of Timken forging steel responds uniformly to heat treatment because every lot has the same physical and chemical properties. For example, we rigidly control chemistry with the help of a direct-reading spectrometer which tells us the exact composition in 40 seconds . . . while the steel is still molten.

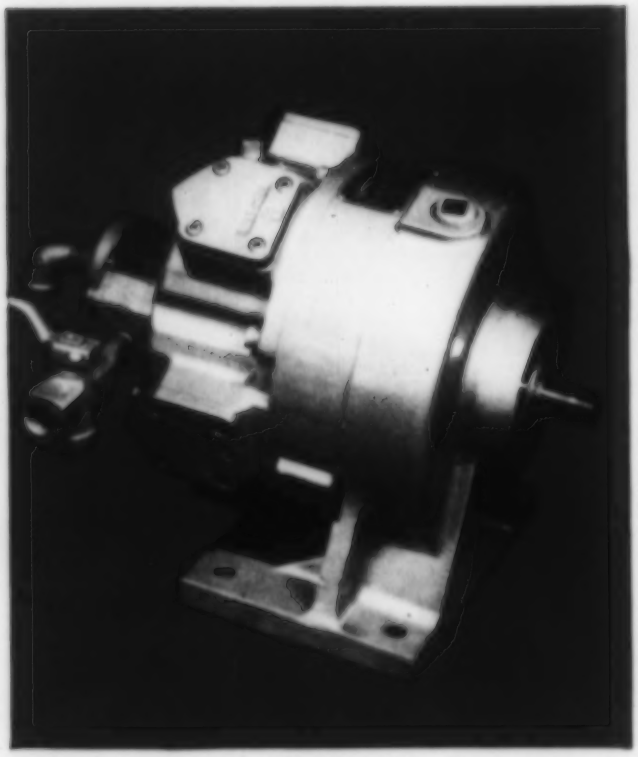
To top it off, Timken steel forging bars *save* you steel because their good dimensional tolerances produce uniform weight multiples with a minimum of steel lost in flashings. Get all these results in your forgings. Specify Timken forging steels. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

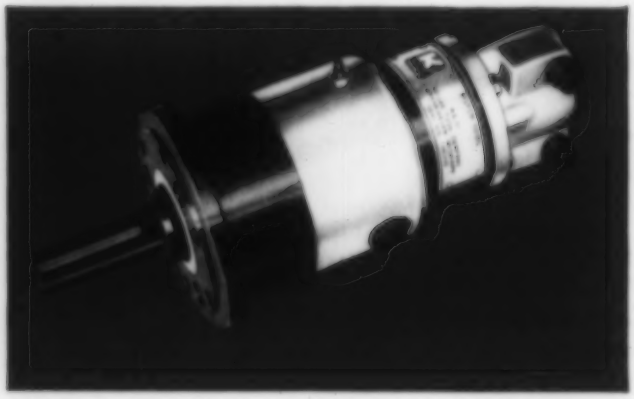
air motor flexibility helps create new designs

AIR MOTORS PROVIDE compact, safe, non-sparking power for continuous or intermittent service. Respond quickly. Will not burn out. Send now for full specifications.



Gardner-Denver Geared and Non-Geared Air Motors — Five radial cylinders develop high torque. One way or reversible rotation. Sizes from 2 to 16 H.P. Send for Bulletin AM-1 for complete information on these famous air motors.

Keller Tool Rotary Vane Air Motors — Compact — powerful — light weight. Heavy-duty construction. Numerous speed and torque ratios. One way or reversible. Sizes up to one H.P. Bulletin No. 71.



Keller Tool Axial Piston Air Motors — High power to weight ratio. Infinitely variable speed in either direction. ½ to 2¾ H.P. Wide range of speeds and torques. Bulletin No. 70.

GARDNER-DENVER

THE QUALITY LEADER IN COMPRESSORS, PUMPS AND ROCK DRILLS FOR CONSTRUCTION, MINING, PETROLEUM AND GENERAL INDUSTRY

Gardner-Denver Company, Quincy, Illinois
In Canada: Gardner-Denver Company (Canada), Ltd.,
14 Curity Avenue, Toronto 16, Ontario

Design for... Heat and Corrosion Resistance with *Carpenter* Stainless Tubing

When hollow parts you're designing are going to wind up in hot spots—and must also resist attacks of strong corrosives—that's the time to "call for Carpenter" Stainless Tubing.

Here's a case in point. A manufacturer of gas-fired household incinerators puts long-life resistance to organic acids and scaling at temperatures of 1300-1600°F into the burner tubes by making them out of Carpenter Stainless Tubing. As a result, the part is guaranteed for many years of service life. Slotting, forming and other fabricating operations involved in making the parts are easily performed—production costs held down... and Carpenter quality and uniformity make the difference.

There are Carpenter analyses to combat every corrosion condition—defeat even the strongest corrodents—and remain scale-free at high temperatures. What's more, you can be sure of getting the uniform properties, tolerances, finish and quality you need for trouble-free fabrication when you specify Carpenter Stainless Tubing.

It may pay you to discuss your product designs with your nearest Carpenter Tubing Representative or Distributor. A NEW bulletin, "Fabricating and Working Data" is yours for the asking.

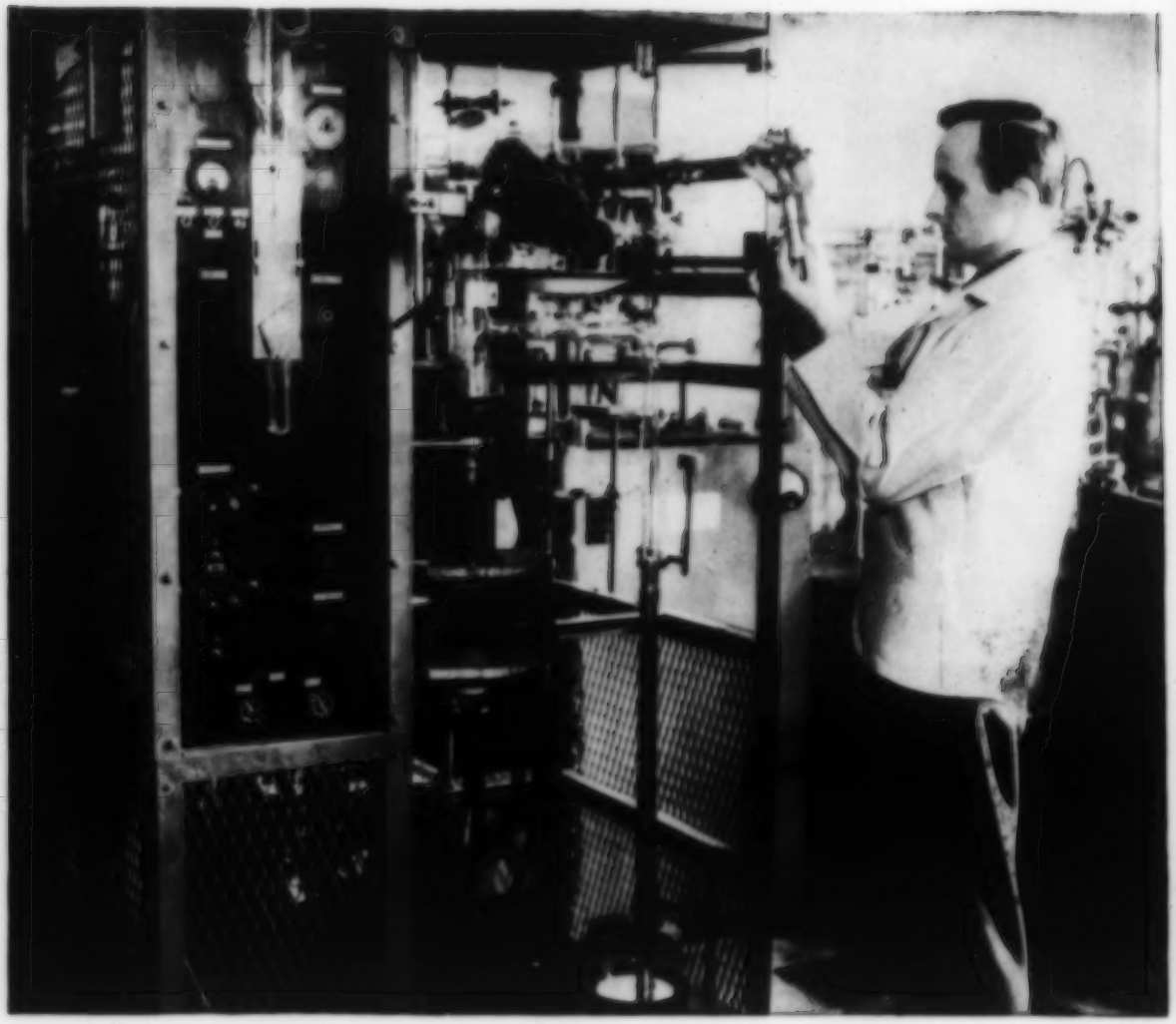
MEMBER

The Carpenter Steel Company
Alloy Tube Division, Union, N. J.

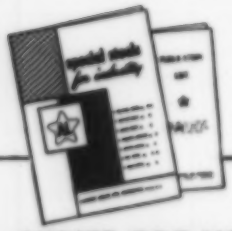
Export Dept.: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"

Carpenter

Stainless Tubing & Pipe



They search so that you may find



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For These Publications

1. SPECIAL STEELS FOR INDUSTRY . . . 16 pages of essential data on the proper selection and application of principal AL special alloy products: stainless, tool and electrical steels and sintered carbides.

2. PUBLICATION LIST . . . a complete listing of all AL publications, both technical and non-technical (over 100 in all), with a handy order form for your convenience.

ADDRESS DEPT. MD-68

The technician above, in the last-word Research Laboratory recently built near our Brackenridge, Pa., plant, is running an involved analytical test on apparatus of our own devising—developed because we wanted more accurate answers on special alloy steel problems than we could get in any other way. In all of the A-L plant laboratories, the hunt for alloy steels of improved properties and greater value is always at full speed, so that *you* can have the materials you need to cut your costs or improve the competitive position of your products. ● Whenever you're trying to take a step ahead in resisting corrosion, heat, wear or great stress, or in securing special electrical characteristics, call on us. ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.***

PIONEERING on the Horizons of Steel

Allegheny Ludlum

WAD 6143 C

Stocks of Allegheny Stainless carried by all Ryerson Steel warehouses

AL LEADING PRODUCER HIGH-ALLOY STEELS

DOW CORNING CORPORATION

Silicone News

FOR DESIGN ENGINEERS

SUNBEAM "FRYPAN": CASE HISTORY OF AN ADVANCED DESIGN MADE PRACTICAL BY DOW CORNING SILICONES

Ingenious design and resourceful use of materials is reflected in the Sunbeam Automatic Frypan, an attractive and original new household appliance, which combines the appeal of a built-in source of controlled heat with the convenience of easy, thorough washability.

These ideal features were made practical through use of Dow Corning silicones. The completely enclosed lead and thermocouple wiring, for instance, is insulated with Silastic, the Dow Corning silicone rubber. Silicone-glass sleeving is also slipped over the wires to assure maximum dependability at operating temperatures in the range of 450 F. And the terminal block to which they are connected is a heat resistant silicone-glass laminate.

Although the Frypan may be almost totally immersed in water, the electrical connections at the base remain dry and easily accessible inside a terminal box sealed with molded Silastic. Extensive research and testing, including several thousand actual immersions, have proved that this gasket maintains a watertight seal even after prolonged exposure to temperatures in the range of 450 F. *No. 42*

Silastic Insulates, Protects Flexible Woven Heater Pad

Proof of the effectiveness of Silastic* encapsulation is found in the performance of this 115-volt flexible heater woven and insulated by the Haddam Manufacturing Co., Haddam, Connecticut, for a classified aircraft use. The combined thermal stability and conductivity of Silastic is so great that the heater will operate indefinitely at temperatures high enough to boil the water in which it is totally submerged. *No. 43*

*T.M. REG. U.S. PAT. OFF.

Silicone Fluid Improves Dashpot Timing Device

The nitrogen impact fishing jar developed by Houston Oil Field Materials, Inc., presents a new approach to the problem of loosening tools jammed in the depths of oil wells. On impact, old style jars shake and strain derricks and pipe strings. The new Homco unit eliminates wear and tear on equipment by concentrating all its 208 ton kick inside the jar attached to the jammed tool.

Another valuable feature of the new Homco jar is regulated impact time. By means of a unique dashpot timing device containing Dow Corning 200 Fluid, the hammer blow can be delayed while the jar is moved into a new postition. By varying the quantity and viscosity of the silicone fluid, the impact time may be varied from a few seconds to half an hour.

Dow Corning 200 Fluid was selected as the dashpot oil after tests proved it to be the most heat-stable fluid available. Organic oils thin out rapidly when subjected to well temperatures and to the heat generated by successive impact blows. But Dow Corning 200 Fluid with its relatively flat viscosity-temperature slope, thins only slightly even after 10 to 15 hours' continuous operation. This change is so slight that it is more than compensated for by expansion of the metal parts and fittings. *No. 44*

Silicone products most widely used are indexed by type of application, in the 1955 Reference Guide to Dow Corning Silicone Products. A brief but comprehensive 8-page summary is given of the properties and applications. With increasing effort devoted to product improvement and cost reduction, such a reference guide to this remarkably stable group of engineering materials becomes increasingly important to design, production and maintenance engineers. *No. 45*

"What's a Silicone?" is the title of a 32 page booklet which answers that often asked question in semi-technical terms. Indexed and illustrated, this booklet has earned an international reputation as the most interesting and informative description of silicones ever published. *No. 46*

Design Edition 11

DOW CORNING CORPORATION · Dept. 6808
Midland, Michigan

Please send me 42 43 44 45 46

NAME _____

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COMPANY _____

STREET _____

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ATLANTA · CHICAGO · CLEVELAND · DALLAS · DETROIT · LOS ANGELES · NEW YORK · WASHINGTON, D. C. (Silver Spring, Md.)
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Earmarks of Quality

with MADISON-KIPP zinc and aluminum die castings

A MOST VITAL FACTOR in designing is to get the "quality look" at no cost increase or even at a saving.

In the Two Circuit Double Break Push Button Micro Hand Switch here illustrated, the first and lasting impression is high quality. The functional holes, bosses, ribs, unyielding strength, and inherent stability are plus factors.

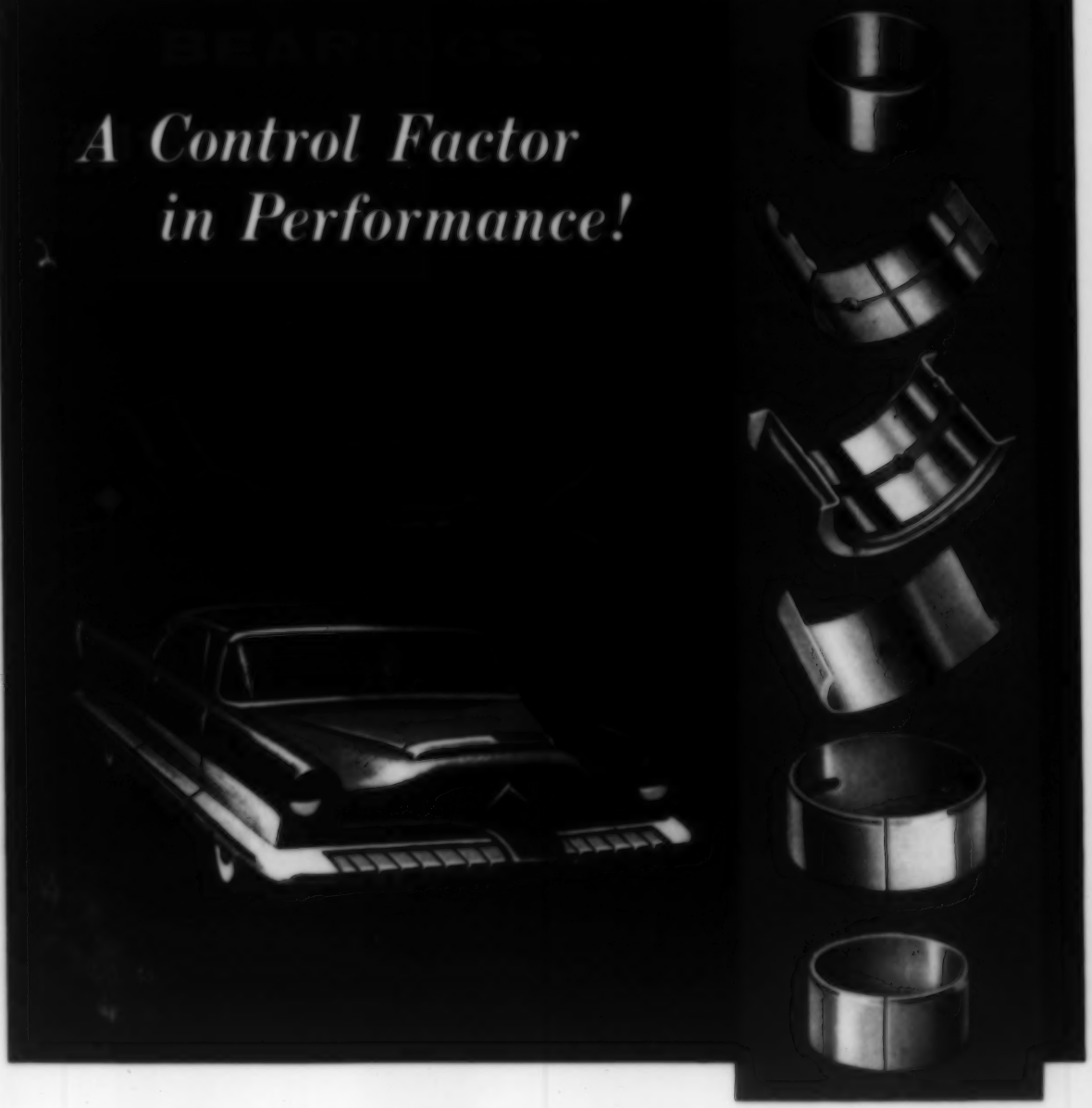
Please clip this ad as a reminder to contact us when you have die casting requirements.

kipp

MADISON-KIPP CORPORATION
210 WAUBESA STREET • MADISON 10, WIS., U. S. A.

• Skilled in Die Casting Mechanics • Experienced in Lubrication Engineering • Originators of Really High Speed Air Tools

A Control Factor in Performance!

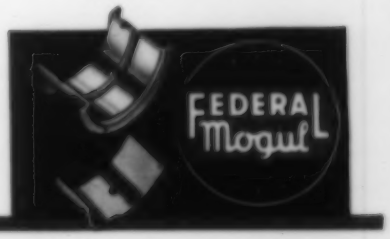


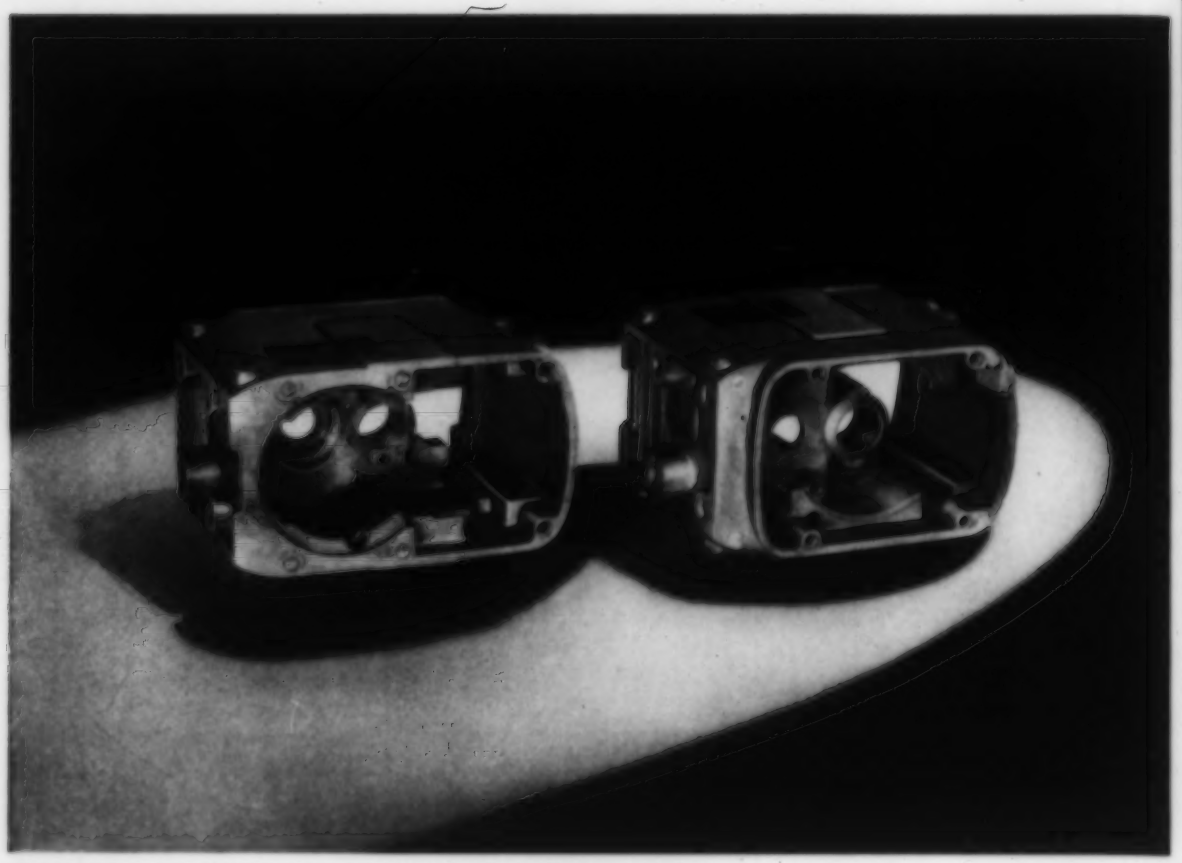
RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

The finest performance in the world is built into American cars—with the help of precision-made sleeve bearings. They are asked to carry the thrust loads of pistons, endure extreme heat, protect the crankshaft and maintain internal lubrication. Their dependability is assured under the most severe load and road operating conditions. We are specialists in quality bearings and bushings for engine, transmission and chassis applications, and a major supplier to the car-building industry. Federal-Mogul Corporation, Detroit 13, Michigan.

SINCE 1899

FEDERAL-MOGUL





PARKER'S MOST IMPORTANT PRODUCT:

Proving That Die Casting Cuts Component Parts Costs

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SYRACUSE, N. Y.
J. C. Palmer • 712 State Tower Bldg.

BELLEFONTE, Penna.
Warren G. Olson • 420 East Linn Street

A sure way to cut component parts costs is to eliminate production operations. In the above part, note the involved coring and other design elements . . . especially the precisely positioned laminated steel insert. This intricate part with the insert cast into place was produced in **one die casting operation** by Parker. A good example of how Parker Die Casting produced component parts to exacting "specs" with a minimum of operation, and, therefore, at lowest possible cost.

The cost and design advantages of Parker Die Castings may save you money on your component parts. It will be worth your while to check. Just call the nearest Parker Sales Engineer listed here or write the factory direct.

Parker White Metal Company • 2153 McKinley Ave., Erie, Pa.

PARKER

ALUMINUM and ZINC die castings POWDERED METAL PARTS

IF...

- You are spending too much time gettin tool to and from an operation
- You are having trouble controlling a tion under tension
- You need a more precise operation trol scrap
- You need hair trigger control of quantity and size
- You want to start and stop your pro line faster
- You would like to leave your producti line virtually unattended hour after hour
- You require re-acceleration of a motor to previous exact speed
- You want centralized control
- Your mechanical transmission parts wearing out or getting out of adjustment

Or if you have other motor-drive probl our sales engineers are prepared to give the benefit of our 50 years' experience. J get in touch with your nearest Reliance di trict sales office, or write to *Applied Engineering Division, Reliance Electric & Engineering Co., 1079 Ivanhoe Road, Cleveland 10, Ohio; Canadian Division, Welland, Ontario.*

L-1456

RELIANCE ELECTRIC AND ENGINEERING CO.

Builders of the Tools of Automation

BARNES PUMPS ARE DESIGNED

to beat Competition!

BUILT-IN RELIEF VALVE SIMPLIFIES PIPING

- **EXCLUSIVE GEAR TOOTH STRUCTURE** — offers excellent volumetric efficiency even with low viscosity fluids and over a wide temperature range.
- **SPRING-LOADED SEAL** — tight synthetic ring retains any oil getting past leak-back ports in bearings
- **SELF-LUBRICATING** — Self Priming-Fluid being pumped acts as a lubricant for all parts.
- **BUILT-IN RELIEF VALVE** — Simplifies piping—guards against excessive pressures — equalizes fluid pressure throughout.
- **ONE SIZE** — Over 15 different capacities — no bigger than a man's fist — range of gear face widths available to fit capacity demands.
- **PORT, DRIVE SHAFT AND MOUNTING COMBINATIONS** — to fit your exact needs.
- **PRECISION TOOLED** — special mass production machinery holds close limits uniformly. Close limits maintained regardless of temperature changes in fluid due to exact expansion and contraction of material used in both gears and housing.

JOHN S.
BARNES
CORPORATION
301 SOUTH WATER STREET • ROCKFORD, ILLINOIS

THE Barnes Constant-Flo Rotary Gear Pump maintains maximum efficiency with the help of a built-in relief valve, which guards against excessive pressures, and equalizes the fluid pressure over a wide range of speeds. It is built into the pump to simplify the piping, eliminate leakage and facilitate easy maintenance.

The valves are pre-set at the factory, for specified pressure, under conditions duplicating those in which the pump will be used.

© 1955 John S. Barnes Corporation, Rockford, Illinois

JOHN S. BARNES CORPORATION
301 South Water St., Rockford, Ill.
Please rush full details on Barnes Hydraulic Pumps.

Name .....
Address .....
City ..... State .....
Title .....

Watch for the informative series of John S. Barnes Corporation ads appearing in this publication each month.

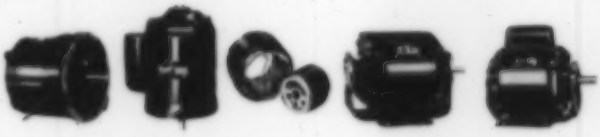
For You..."Right-Now" Help From an Emerson-Electric Motor-Drive Specialist

What kind of motor-drive help do you need—now or later? If it has anything whatever to do with appliance motors, here's your man—with a background of 65 years of specialized experience in power drives, he can give you valuable on-the-spot help.

An Emerson-Electric motor-drive specialist will start at the beginning, or idea stage, of your problems—will stay with it through every phase of development, test and application stages—will work closely with your engineering and management personnel on any product or sales improvement you have in mind.

Call an Emerson-Electric motor-drive specialist . . . even if you have no immediate problem, he'll be glad to confer with you. He may be able to make a suggestion you'll find valuable. No obligation, of course.

Emerson-Electric supplies motors for appliances and equipment principally in these classifications. Oil Burner • Blowers • Unit Heaters • Water Circulators • Air Conditioning • Washers • Driers • Ironers • Garbage Disposers • Refrigerators • Freezers • Water Pumps • Air Compressors

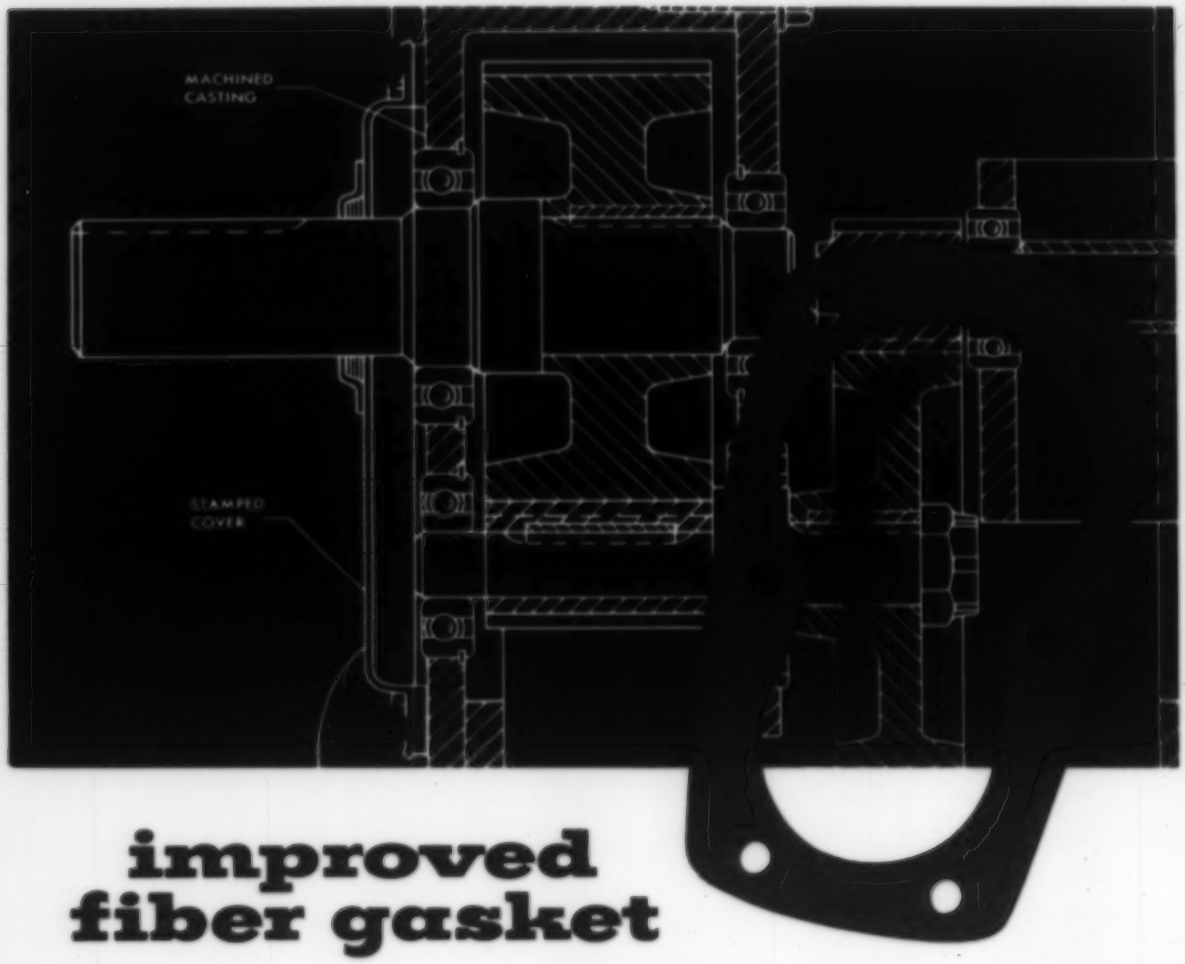


Emerson-Electric
of St. Louis • Since 1890

Write THE EMERSON ELECTRIC MFG. CO., ST. LOUIS 21, MO., for bulletins listed below.

- ☐ M 4018-A Capacitor-Start
- ☐ M 4018-B Split-Phase
- ☐ M 4018-C Integral
- ☐ M 4018-D Fan Duty
- ☐ M 4018-E Oil Burner
- ☐ M 4018-F Jet Pump
- ☐ M 4018-G Blower

BRANCHES: New York 7, N. Y., 11 Park Place • Chicago 23, Ill., 1623 S. Pulaski Road • Syracuse, N. Y., 209 Oakley Drive • Detroit 7, Mich., 1375 E. Jefferson Ave. • Los Angeles 42, Calif., 5415 York Blvd. • Davenport, Iowa, 617 Brady St. • Cincinnati 11, Ohio, 2917 Ratterman Ave.



improved fiber gasket

stops bolt torque loss, ends cover plate leakage

Customers were complaining that frequent tightening of bolts was necessary to prevent oil leaks at the cover plate of a motor speed reducer. The manufacturer learned that the molded seal between the cover plate and gear housing flowed under pressure and permitted oil to leak. The situation was especially serious since many of the speed reducers were used in food processing equipment where even slight oil leaks could not be tolerated.

By changing from a cast metal to a stamped face plate and using a fiber gasket, the manufacturer hoped to reduce torque loss. But when he tested several conventional fiber materials in the new joint, each one in time lost its saturant, shrank, and leaked.

An efficient seal was found, however, when Armstrong CS-301 Accopac® fiber sheet was used. This low-cost gasket material retained its non-extractable latex binder . . . it did not shrink or leak. And its excellent kickback maintained bolt torque.

The dependability of Armstrong Accopac helped this manufacturer find an economical solution to a serious problem. Possibly it can do the same for you.

FREE 24-PAGE MANUAL—For data on Accopac and facts on Armstrong synthetic rubber, cork composition, and cork-and-rubber, look for "Armstrong Gasket Materials" in Sweet's product design file. For your own copy, write Armstrong Cork Company, Industrial Div., 7008 Dean St., Lancaster, Pa. **When you order from your local gasket fabricator, be sure to specify Armstrong Gasket Materials.**

Armstrong Accopac

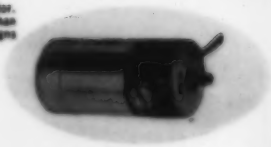
. . . used wherever performance counts

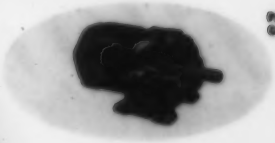
Torq-Master, used with torque converters and fluid couplings in the lumber industry

Giant gear and rack

Right angle vertical pump drive

Miniature motor. One of more than 50 basic designs



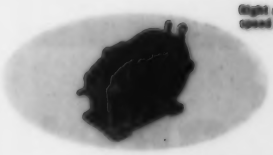

Pacific, G-E gearmotor

look to
WESTERN GEAR for

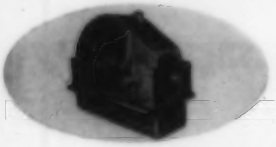
- custom engineering
- specialized machinery for every purpose
- complete line of electro-mechanical catalog products
- gears of all types and sizes

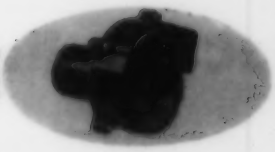
Illustrated are only a few of the wide variety of both custom and standard products designed and manufactured by Western Gear

Manifolding press

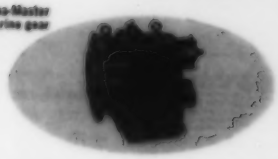

Right angle speed reducer

High speed unit




Centrifugal blower, one of many design sizes

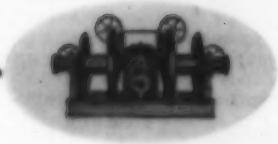
Helicopter rotor drive unit


Sea-Master marine gear

Miniature precision differential unit

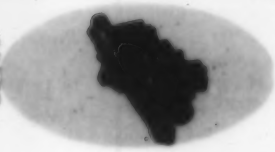
Aircraft cable drum type hoist, hydraulic, pneumatic or electric drive

Travel winch



Rotary actuator powered by both hydraulic and electric motors. One of hundreds of basic designs

Horizontal stabilizer actuator unit. AC and DC power providing three speeds for manual, auto pilot and coarse control



"The difference is reliability" • Since 1888

Engineering service available without obligation. Let us quote you on your needs.

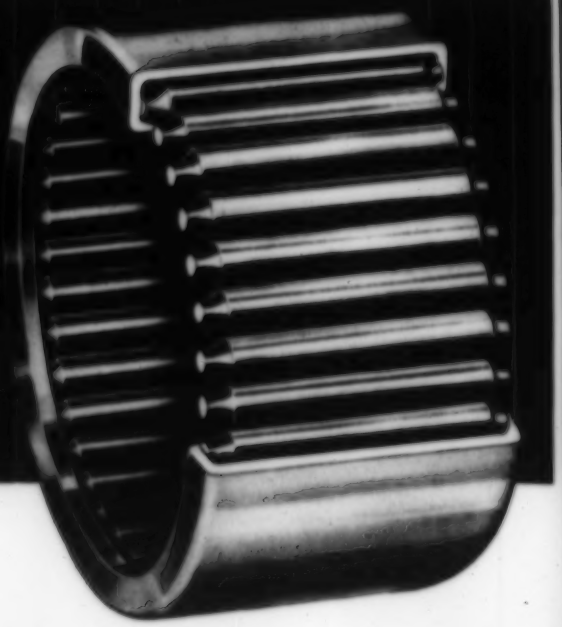
WESTERN GEAR

PACIFIC-WESTERN PRODUCTS | POWER TRANSMISSION GEARS • MACHINERY

Address Executive Offices, Western Gear, P.O. Box 182, Lynwood, California

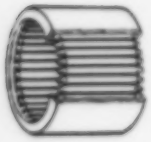
PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.), SEATTLE AND HOUSTON...REPRESENTATIVES IN PRINCIPAL CITIES 5161

here's why...



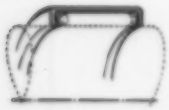
TORRINGTON

DC needle bearings give high-capacity performance in minimum space



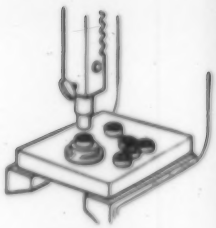
Unique construction—accurately drawn, surface-hardened shell retains rollers and serves as outer raceway.

Full complement of small diameter rollers—precision-ground and through-hardened—assures top capacity by distributing load over large number of contacts.



Turned-in lips of the case-hardened outer shell keep dirt and grit out, lubricants in—while retaining trunnion ends of rollers. All wear surfaces of outer race are case-hardened.

No inner race required on surface-hardened shafts—reduces space requirements, lowers unit costs.



Simple assembly—arbor press seats bearing in round housing bore. No collars, shoulders or retaining rings needed.

Closed end type DC Needle Bearings are available for stub shaft applications. The closed end provides a perfect seal at no extra cost.

Needle Bearings are made in a Precision Series for most applications and an Extra Precision Series where low radial play and minimum eccentricity are required. Easy lubrication through optional hole in shell or through hole in shaft assures long service life. Bearings can be pre-packed with suitable grease for those applications requiring grease lubrication.

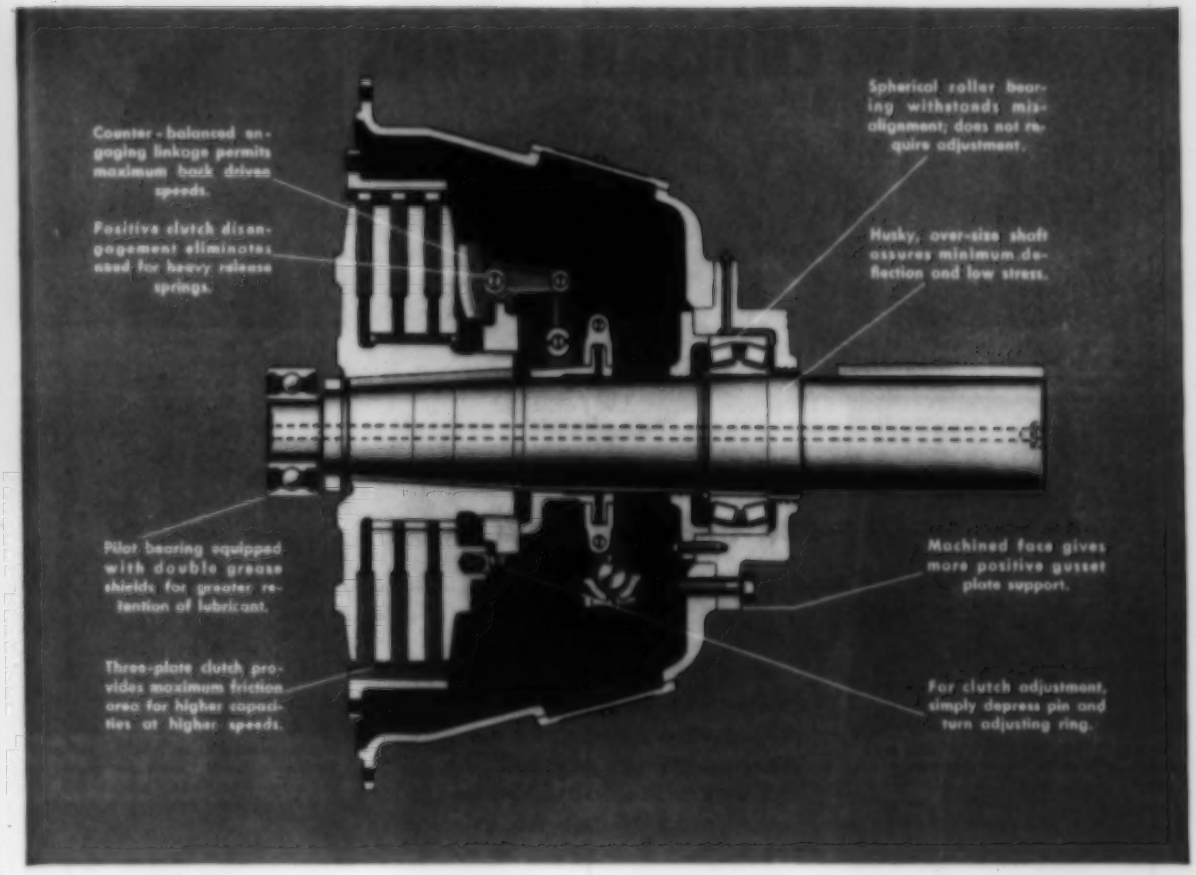
See our new Needle Bearing Catalog in the 1955 Sweet's Product Design File—or write direct for Catalog No. 55.

THE TORRINGTON COMPANY
Torrington, Conn. **South Bend 21, Ind.**

District offices and distributors in principal cities of United States and Canada

TORRINGTON NEEDLE BEARINGS

Needle • Spherical Roller • Tapered Roller • Cylindrical Roller • Ball • Needle Rollers


Counter-balanced engaging linkage permits maximum back drive speeds.
Positive clutch disengagement eliminates need for heavy release springs.
Spherical roller bearing withstands misalignment; does not require adjustment.
Husky, over-size shaft assures minimum deflection and low stress.
Pilot bearing equipped with double grease shields for greater retention of lubricant.
Machined face gives more positive gusset plate support.
Three-plate clutch provides maximum friction area for higher capacities at higher speeds.
For clutch adjustment, simply depress pin and turn adjusting ring.

A new Power Take-Off for higher-speed, higher-horsepower engines

Here is the all-new Twin Disc Model SP-318 heavy-duty Friction Power Take-Off—designed and engineered especially to meet the extra requirements of the new engines in the 350 to 375 hp range, operating up to 1800 rpm.

Extremely compact for its capacity, the new Twin Disc Power Take-Off is provided with an S.A.E. #0 flywheel housing. With triple driving plate construction, it assures ample friction surfaces to withstand high horsepower loads. And with solid driving plates, the new PTO effectively permits higher safe permissible speeds.

The pilot bearing of the new Power Take-Off is composed of a single row of balls, operating in bearing races of double-row width . . . providing improved accommodation of minor misalignment inherent in installations of this nature. Pilot bearings of this type provide additional space for lubricant, which is more effectively retained by the double grease shield construction. Although this construction is usually referred to as "sealed for life," the clutch shaft is drilled to provide for relubrication of the pilot bearing in the usual manner.

Another outstanding feature of the new Twin Disc Power Take-Off is the use of a spherical bearing which does not require adjustment. With its inherent ability to permit angularity, the spherical bearing is more resistant to overload and destructive forces resulting from heavy side loads.

For complete information on the new Twin Disc SP-318 Friction Power Take-Off (and the SP-314, a smaller model of the same new design, for engines in the 225 hp range operating at 2200 rpm), write to the Twin Disc Clutch Company, Racine, Wisconsin.

TWIN DISC

TWIN DISC

Friction Clutches and Fluid Drives

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin
Hydraulic Division, Rockford, Illinois

CHIKSAN OFFERS

Chiksan swivel joints in landing gear, braking and hydraulic control systems on Lockheed's Super-Constellation.

UNLIMITED FLEXIBILITY FOR ORIGINAL EQUIPMENT MANUFACTURERS

Johnson Motors cut fluid losses 75%—setting-up time 75% with Chiksan joints on their 48 die-casting machines.

Chiksan high-pressure swivel joints provide complete flexibility and safety in steam lines on platen presses.

Chiksan swivel joints and assemblies provide unlimited flexibility in small space. These revolutionary joints turn with full 360° rotation in 1, 2, and 3 planes handling air, hydraulics, fuels, oils, water and other fluids.

There are over 1,000 different types, styles and sizes for pressures and services from 28" vacuum to 15,000 psi and for temperature ranges from minus 75° F. to a plus 500° F. Packing materials have been designed for each specific service.

Wherever unlimited flexibility is required in your research, design and engineering of new equipment for modern industry—CHIKSAN will help you find the solution.

Ermold automatic bottle unpacker uses Chiksan hydraulic joints for flexibility and stamina in limited space.

Most hose reel manufacturers employ Chiksan swivels for pressure and vacuum tight connections with low torque.

Chiksan high-pressure swivel joints are installed for dependability and safety in injection molding equipment.

Colorado School of Mines turned to Chiksan swivel joints for air and hydraulic lines on shale mining equipment.

Write for Catalog G-4, Dept. No. 168

The Flow of Enterprise Relies on

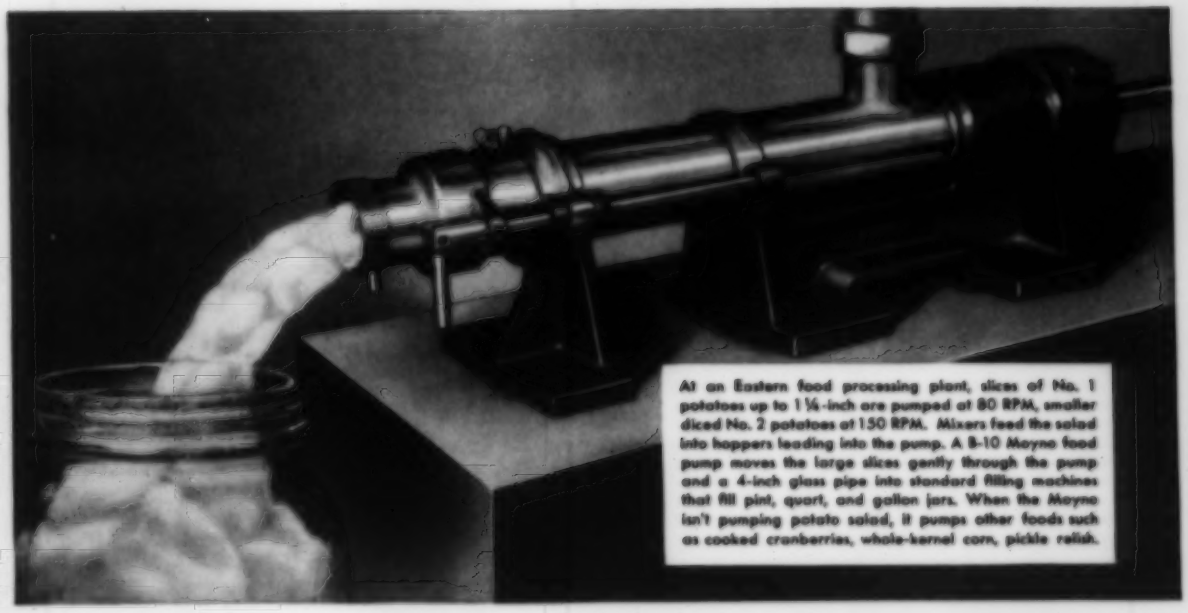
CHIKSAN

Ball-Bearing Swivel Joints

Chiksan swivel joints are used on the coolant lines on the 160" plate mill in U. S. Steel's Homestead Works.

CHIKSAN COMPANY • BREA, CALIFORNIA • Chicago 3, Illinois • Newark 2, New Jersey

Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Chiksan Export Company (Subsidiary), Brea, California • Newark 2, N. J.



At an Eastern food processing plant, slices of No. 1 potatoes up to 1¼-inch are pumped at 80 RPM, smaller diced No. 2 potatoes at 150 RPM. Mixers feed the salad into hoppers leading into the pump. A 8-10 Moyno food pump moves the large slices gently through the pump and a 4-inch glass pipe into standard filling machines that fill pint, quart, and gallon jars. When the Moyno isn't pumping potato salad, it pumps other foods such as cooked cranberries, whole-kernel corn, pickle relish.

This Moyno® Pumps Potato Salad With Slices Up To 1¼-inch...Without Crushing!

The Moyno can pump potato salad and a lot of other materials without making mush out of them—because of the unique *progressing cavity* principle.

Moynos have no valves and pistons, no vanes or other devices that cause churning and turbulence. The Moyno has a simple screw-like rotor turning within a double-threaded stator. This design creates cavities which progress smoothly toward the discharge end of the pump, carrying the material being handled. The material is not squeezed or churned.

Pumps Practically Anything

That's why the Moyno successfully handles such hard-to-pump materials as non-pourable pastes, frits, plaster, highly volatile liquids, and materials containing large particles, such as potato salad, fruit, cherries, chow mein—even oysters! In fact, the Moyno handles practically anything that will pass through a pipe.

Many Other Advantages

Moynos pump many hard-to-pump materials with a minimum of abrasion and wear. Many plants have adopted Moynos simply because they last so long.

Moynos provide positive displacement. Moynos can pull up to 29 inches vacuum while discharging under pressure. Big Moynos deliver up to 500 gpm; can provide pressures up to 600 psi in the smaller frame sizes. They even get up to 1000 psi momentarily.

The Moyno is reversible—it pumps equally efficiently in either direction.

With the Moyno, accurately metered flows are obtainable by regulating operating speed.

Moynos are trouble-free. They are self priming; won't cavitate or vapor-lock. There's just one moving part—no valves to stick, no pistons to gum up. Built for tough service. Easy to maintain. Moyno pumps are easy to take apart for cleaning.

Write For Bulletin

You may save a good deal of money or solve a tough problem by finding out about this simple, versatile pump. Write for Bulletin 30MD.

HOW IT WORKS

Rotor is like a stretched-out corkscrew. It turns within a stator that has a double internal thread. Thus rotor and stator form closely fitted cavities. As the rotor turns, these cavities progress evenly toward the discharge end of the pump without closing up. That's why the Moyno easily handles materials without crushing, churning, or aerating; and why it can handle so many different things—solids in suspension, pastes, abrasives, highly volatile liquids, tars, soaps, caustics—even cement and plaster.

FOR DESIGN ENGINEERS

Moynos are available in small sizes and special designs for use in automatic washers, drink dispensers, sprayers, oil burners, machine tools, gasoline pumps, and a wide variety of other equipment. If you are designing machinery, we'll work with you, in confidence, to integrate pump design with your problem.

ROBBINS & MYERS, INC.

SPRINGFIELD, OHIO • BRANTFORD, ONTARIO

Fractional and Integral HP Motors | Desk, Window, and Household Fans | Hoists and Cranes | Moyno Pumps | Propellair Industrial Ventilating Equipment

R&M MOTOR PARTS AT WORK

A prominent passenger car manufacturer gets eleven times more chassis per gallon—reducing paint and production costs substantially—with the efficient, high-quality electrostatic paint spray process of the Ransburg Electro-Coating Corp., Indianapolis, Ind. Robbins & Myers polyphase motor parts are utilized to atomize the paint spray in an electrostatic field. The spray is attracted to the products, which are grounded through the hanger, producing a high degree of uniformity of finish.

◀ Rugged rotor and stator for a polyphase portable tool. The rotor consists of squirrel cage, embedded in laminated core with bars and end rings of copper, brazed or welded together. The stator has a high-grade silicon steel core with top-quality rag paper used to insulate the coil from the core. The finished winding is taped and thoroughly impregnated with high-grade synthetic resin base varnish to assure trouble-free operation with minimum danger of short circuits and grounds.

ROBBINS & MYERS, INC.

MOTOR DIVISION: SPRINGFIELD 99, OHIO • BRANTFORD, ONTARIO

Fractional & Integral h.p. Motors & Generators

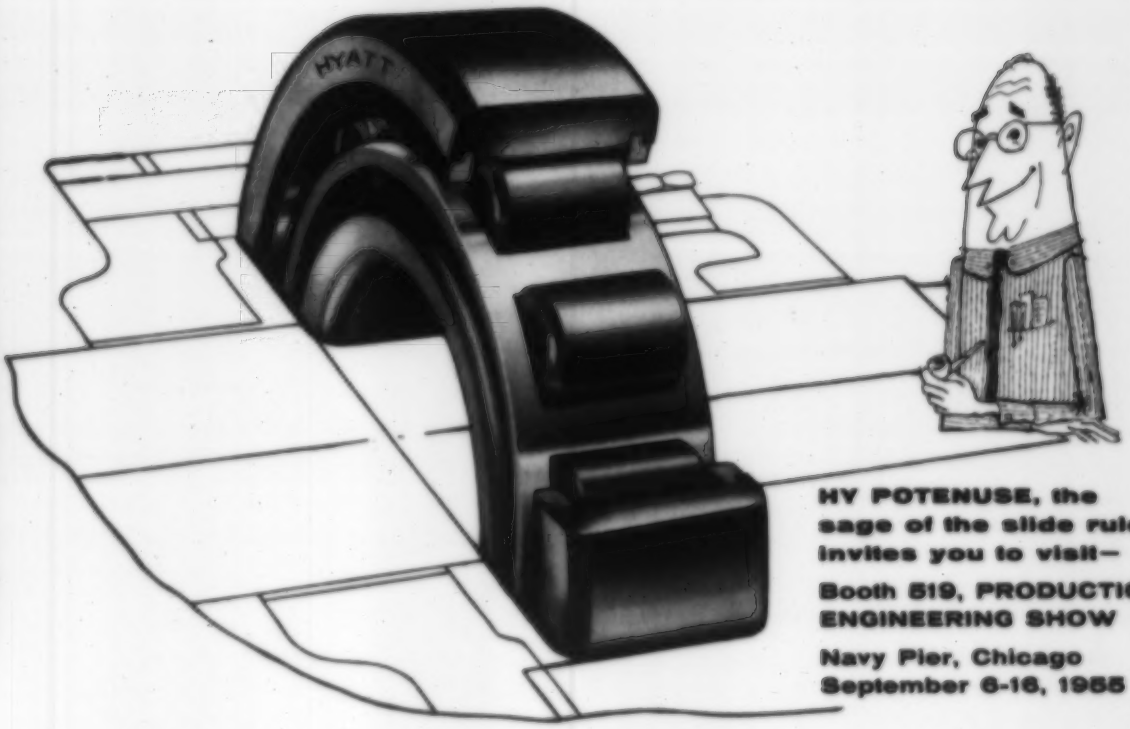
Household Fans

Electric & Hand Hoists & Cranes

Moyno Pumps

Propellair Industrial Ventilating Equipment

How Hy-Loads can help you LICK LATERAL SHAFT EXPANSION!



HY POTENUSE, the sage of the slide rule, invites you to visit—

Booth 519, PRODUCTION ENGINEERING SHOW

Navy Pier, Chicago
September 6-16, 1955

YOUR COMPLETE LINE OF CYLINDRICAL ROLLER BEARINGS

HY SAYS:

Ever stumped by a spot where the shaft heats up and expands laterally—say in an electric motor? You know what happens with laterally locked bearings—you get cramping, misalignment, trouble with a capital T!

But a HYATT Cylindrical Roller Bearing solves all those problems so simply! It allows the shaft to float horizontally—"free lateral," we call it—and automatically compensates for expansion *without changing the bearing centers.* If you haven't a HYATT catalog handy, better send for yours right now. It'll show you exactly which bearing to use where, and help you find the *right* answers to a lot of pesky bearing problems. *Remember, you can't go awry when you specify—*

HYATT ROLLER BEARINGS

STRAIGHT | BARREL | TAPER

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, NEW JERSEY

Norgren ... the most complete line of AIR

FOR BETTER PERFORMANCE, LONGER LIFE,

for Air Tools, Air Cylinders, other Air Equipment

79 MODELS...3 OZ. TO 5 GAL. OIL CAPACITIES...

OIL-FOG LUBRICATORS

for Tools, Cylinders and other Air Equipment

3 OZ. OIL CAPACITY

⅛" pipe size. Permanent, metal oil reservoir. Model 399L8-2.

¼ PT. OIL CAPACITY

¼" and ⅜" pipe sizes. Replaceable, transparent oil reservoir. Reversible. Series O-40.

¼" pipe size. Permanent, metal oil reservoir. Model 399-2

½ PT. OIL CAPACITY

5 pipe sizes from ¼" to 1" incl. Replaceable, transparent oil reservoir. Reversible Series O-41 and O-42.

5 pipe sizes from ¼" to 1" incl. Replaceable, metal oil reservoir. Reversible. Series SO-41 and SO-42.

1 QT. OIL CAPACITY

5 pipe sizes from ¼" to 1" incl. Replaceable, metal oil reservoir. Reversible. Series S406.

1¼" and 1½" pipe sizes. Permanent, metal oil reservoir. Series 406

2 QT. OIL CAPACITY

5 pipe sizes from ½" to 1½" incl. Permanent, metal oil reservoir. Series 408.

2 GAL. OIL CAPACITY

5 pipe sizes from ¼" to 1" incl. Replaceable, metal oil reservoir. Reversible. Series X400 and X402.

1¼" and 1½" pipe sizes. Replaceable, metal oil reservoir. Series X406.

5 GAL. OIL CAPACITY

5 pipe sizes from ¼" to 1" incl. Replaceable, metal oil reservoir. Reversible. Series Y400 and Y402.

1¼" and 1½" pipe sizes. Replaceable, metal oil reservoir. Series Y408.

MICRO-FOG LUBRICATORS

for Tools, Cylinders and other Air Equipment

⅓ PT. OIL CAPACITY

¼" and ⅜" pipe sizes. Replaceable, transparent oil reservoir. Series 30-40-L.

½ PT. OIL CAPACITY

Constant Oil Level

5 pipe sizes from ¼" to 1" incl. Replaceable, transparent oil reservoir. Series 30-41-LC.

Without Constant Oil Level

5 pipe sizes from ¼" to 1" incl. Replaceable, transparent oil reservoir. Series 30-41-L.

1 QT. OIL CAPACITY

5 pipe sizes from ¼" to 1" incl. Replaceable metal reservoir. Constant Oil Level. Series S3406-LC.

1¼ GAL. OIL CAPACITY

5 pipe sizes from ¼" to 1" incl. Replaceable, metal oil reservoir. Constant Oil Level. Series X3400-LC.

4½ GAL. OIL CAPACITY

5 pipe sizes from ¼" to 1" incl. Replaceable, metal oil reservoir. Constant Oil Level. Series Y3400-LC.

OVER 1,100,000 NORGREN LUBRICATORS PUT TO USE IN INDUSTRY

Superheaters of 300,000 kw Steam Generator. Safety blow-off valves, exhausting to atmosphere, have Penflex expansion joints.

PENFLEX

"give-and-take" prevents blow-outs on blow-offs

Penflex Galvanized Steel Interlocked Tubing (8" I.D.), flanged at both ends. Installed as expansion joints on safety blow-off valves, they take up to 850 psi steam pressure at 900°F.

Power plant applications like this one can't use less than Penflex Metal Tubing offers in flexibility, strength, and tightness. When safety valves go, expansion joints must hold. Penflex joints *do*. That's because they can give with the pressure and take it, too.

Thermal expansion at 900°F. . . . pressures up to 850 psi . . . impact and pipe movement under these strains—all are safely handled by Penflex. Forty-two complete units in this big power plant are protected from blow-outs by Penflex.

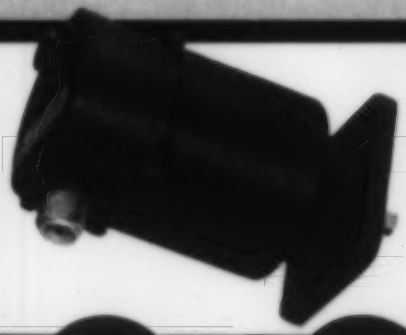
There are hundreds of other applications in the steam and diesel power fields for Penflex Interlocked Tubing and Penflexweld High-pressure Tubing. Call in the Penflex engineer to help you on your own particular problems. In the meantime, write for "Flexineering," your guide in buying and using Penflex Flexible Metal Tubing. There is no charge or obligation.

Pennsylvania Flexible Metallic Tubing Company, Inc., 7239 Powers Lane, Phila. 42, Pa.
Branch Sales Offices: **Boston • New York • Chicago • Houston • Cleveland • Los Angeles and Distributors in Principal Cities**

COMBINES FLEXIBILITY WITH DURABILITY

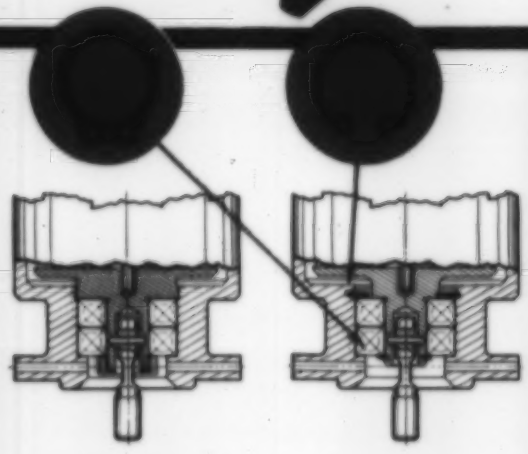
it's our business
to make stampings like these
for your business
G. P. & F.
meets your needs for large and medium size seamless stampings PLUS complete finishing and assembly facilities
Shown here are just a few of the hundreds of different kinds of seamless drawn stampings we have manufactured for America's foremost companies. We made them economically, we made them right, we made them on time.
Our services do not end with stamping. We have complete facilities for finishing and assemblying, galvanizing, spray finishing, vitreous enameling, welding. If desired, we even package your products and ship to your customers!
Over 1000 skilled people . . . 293 deep draw and stamping presses . . . 97 welding machines . . . backed by 75 years' experience . . . are at your beck and call. Get full details . . . now!
Write for your copy of booklet—"Science and Skill in Sheet Metals." It illustrates many jobs produced for G. P. & F. customers . . . gives complete data on our facilities.
G P F

10 Waldes Truarc rings speed assembly— Eliminate parts and machining in precision control



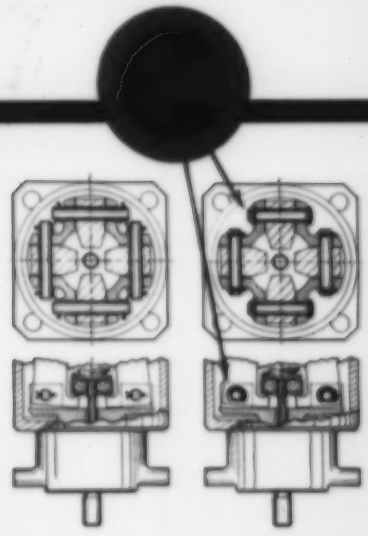
Kahn Rotary Speed Control

Kahn and Company, Inc., of Hartford, Conn., use a total of 10 Waldes Truarc Retaining Rings in this new mechanical-electric translator for automatic control of rotary speed. Truarc rings act as positioners and retainers to eliminate parts, simplify operations, save labor, and speed assembly.



Rotor Installation. In the old way, ball bearing was retained by a threaded shoulder and threaded bearing cup retainer.

New way, using two Truarc Rings (Series 5100 and 5000) eliminates 4 threading operations, bearing shoulder and threaded bearing cup. Assembly is quicker and easier, two ounces lighter.



Flyweight Assembly. Formerly, 2 holes had to be drilled in each of the 4 pivots, and 8 cotter pins were required.

The new way, using 8 Truarc E-Rings (Series 5133), replaces holes with grooves, reduces pivot size, leaves no projecting parts. Rings snap into place, speed assembly time by three minutes per unit.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product... to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types... as many as 97 different sizes within a type... 5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today... let our Truarc engineers help you solve design, assembly and production problems... without obligation.

For precision internal grooving and undercutting ... Waldes Truarc Grooving Tool!

Send for new catalog supplement

WALDES

TRUARC®

RETAINING RINGS

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
(Please print)

Name.....

Title.....

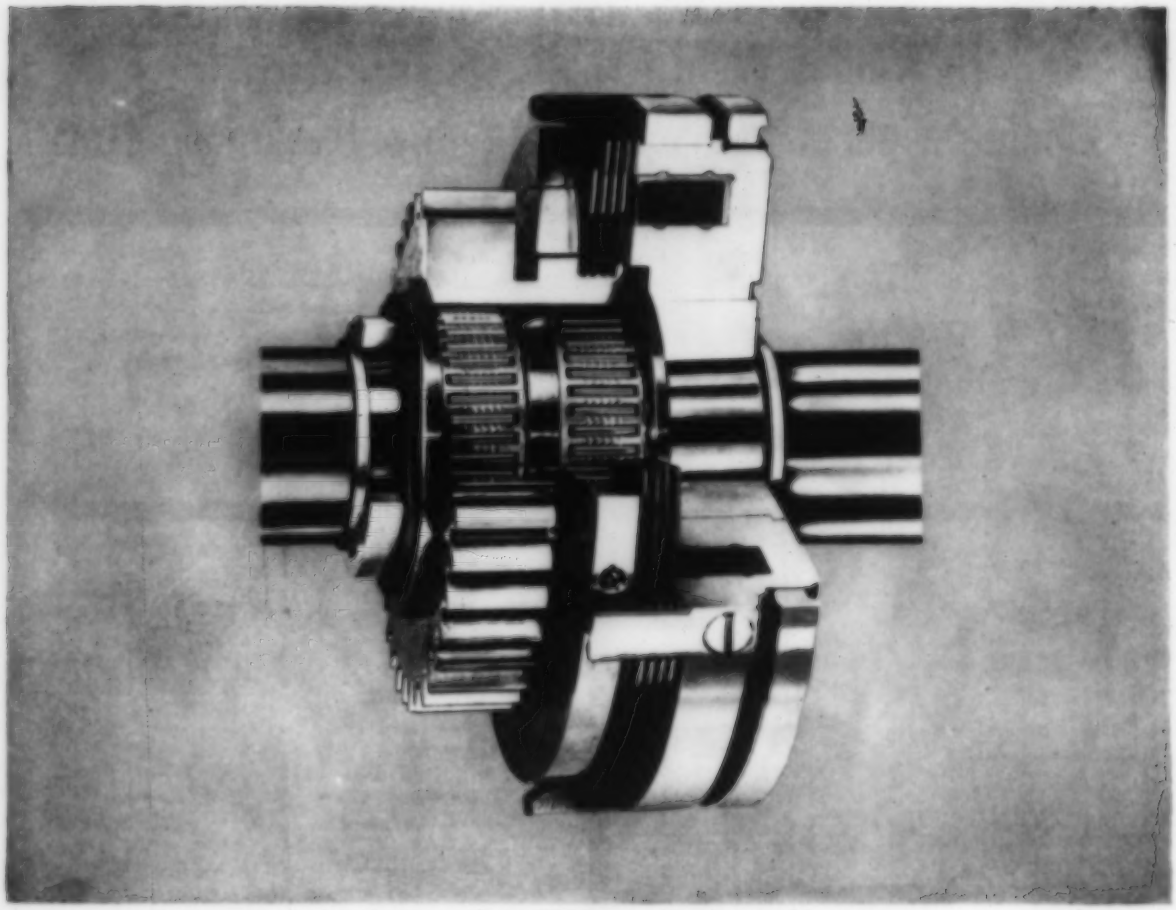
Company.....

Business Address.....

City.....Zone.....State.....

RDM7

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.



Cutaway of Type "H" Electro Clutch Assembly

Performance Proved*

I-T-E Electro Clutch is positive in action, applies torque fast and smoothly, never requires adjustment

While the I-T-E Electro Clutch is new, it is not untried. Users invariably find that this dependable unit is positive in action, applies torque fast and smoothly, requires minimum maintenance. Extensive load and life tests have proved the advantages of the I-T-E Electro Clutch. More and more, machine tool manufacturers are standardizing on it.

I-T-E Electro Clutch equipped machines can be programmed simply and directly from push buttons, limit switches or relays. I-T-E Electro Clutches are available in ratings from 3.2 to 45,000 ft. lbs. running torque.

Application engineering service is available without obligation. Write for illustrated bulletin. I-T-E Circuit Breaker Company, Transformer and Rectifier Division, 19th & Hamilton Sts., Phila. 30, Pa.

***Accepted by major machine tool builders. Names upon request.**

I-T-E CIRCUIT BREAKER COMPANY Transformer & Rectifier Division

I-T-E

Use WELDED STEEL for Greater Strength with Less Weight!

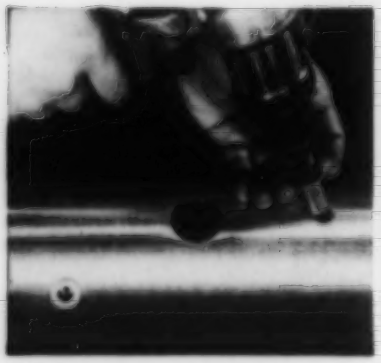
Parts, assemblies and products, such as those illustrated at left, and the steam condenser unit being fabricated in the illustration above, are typical of thousands of Steel-Weld Fabricated units produced and machined by Mahon for hundreds of manufacturers of processing machinery, machine tools, and other types of heavy mechanical equipment. Mahon's service to buyers of welded structural or heavy plate fabrications is complete—including magnetic and radiographic inspection, machining, and assembling if desired. If you are a buyer of weldments, or welded steel in any form, you, too, will find in the Mahon organization a unique source . . . a source where design skill and advanced fabricating techniques are supplemented by craftsmanship which assures a smoother, finer appearing job embodying every advantage of Steel-Weld Fabrication. See Sweet's Product Design File for information, or write for Booklet showing Mahon facilities and capabilities in this field.

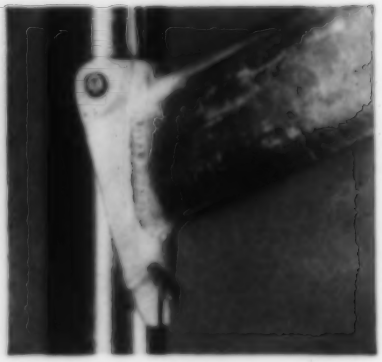
THE R. C. MAHON COMPANY
DETROIT 34, MICHIGAN

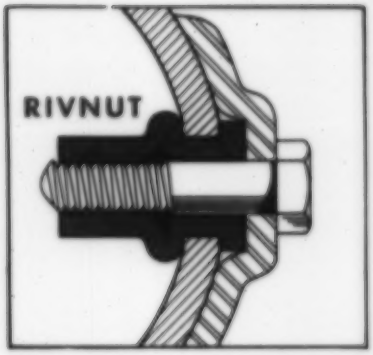
Engineers and Fabricators of Steel in Any Form for Any Purpose

MAHON

3 B. F. Goodrich RIVNUTS replace 4 nuts—cut assembly costs 50%







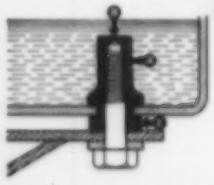
B. F. GOODRICH RIVNUTS provide a firm, accurate nut plate in one, quick operation. Nuts, welding, tapping and clinching are eliminated.

In the street light application illustrated, it used to take two men to fasten the arm bracket to the pole with nuts and bolts. Then Pfaff & Kendall, world's largest supplier of tubular aluminum poles, redesigned the unit to use Rivnuts. Now one man does the job in the same amount of time.

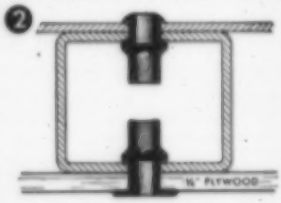
At the factory, (top left) a worker installs the Rivnuts in the aluminum pole in seconds. In the field, the assembler slips the slotted part of the arm bracket over a bolt screwed halfway into the lower Rivnut. Resting the arm on this bolt, he screws the top two in place; tightens all of them (middle photograph). Tests show that the pole or arm bracket will fail before the Rivnuts.

If you're looking for a fastener that can help you cut costs, get more information on Rivnuts or engineering help by writing: The B. F. Goodrich Company, Dept. MD-85, Akron, Ohio.

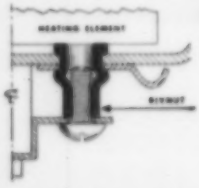
If you have fastening jobs like these, get B. F. Goodrich RIVNUTS



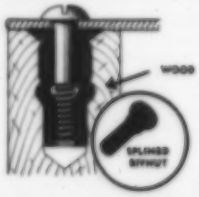
ELIMINATES BRAZING! Rivnuts with closed end (B) are installed in one-tenth the time it took to braze nut plates on oil reservoir tanks. Leaking, warping and thread cleaning are eliminated (A). Spacer head (C) positions tank.



FASTENS PLYWOOD TO STEEL! Easier to install than wood or self-tapping screws, Rivnuts fasten plywood walls to tubular steel sections in trailers. No wood filler needed.



ELIMINATES REINFORCING PLATE! In assembly of vaporizers, Rivnuts do away with reinforcing plate, don't turn under torque, hold flange securely without bending. Result: less assembly time, fewer parts, better product.



GIVES 6 CLEAN THREADS IN WOOD! Special Rivnut for solid fastening in wood eliminates wood screws, provides 6 metal threads for attachment bolt. Bulge formed by upsetting holds Rivnut fast. Splined shaft keeps it from turning.

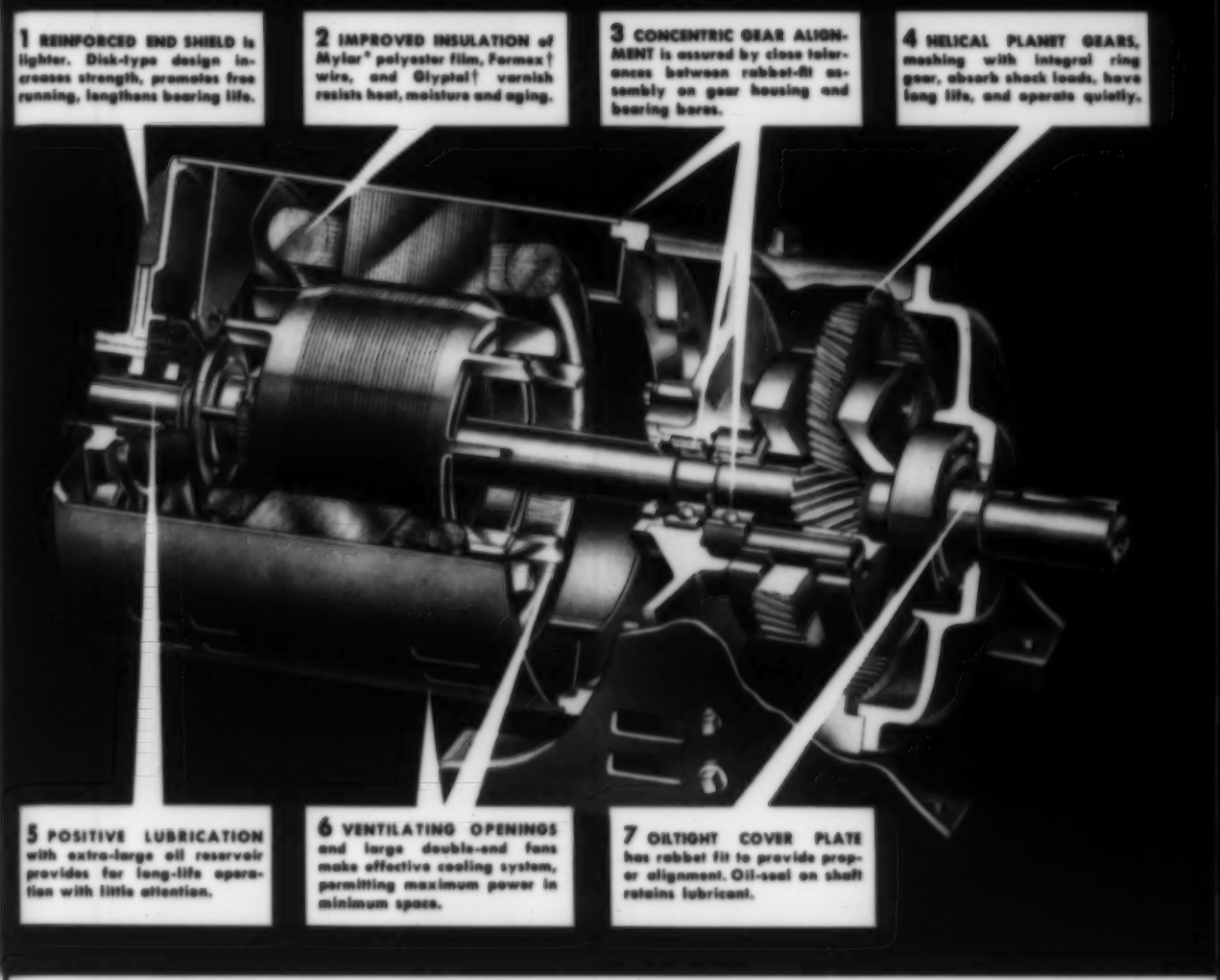
SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how you can use Rivnuts to fasten TO and fasten WITH. Explains construction, simplicity of installation. Get your free copy today by writing to: The B. F. Goodrich Company, Department MD-85, Akron, Ohio.

B.F.Goodrich

RIVNUT

The only one-piece blind rivet with threads


1 REINFORCED END SHIELD is lighter. Disk-type design increases strength, promotes free running, lengthens bearing life.
2 IMPROVED INSULATION of Mylar* polyester film, Formex† wire, and Glyptal† varnish resists heat, moisture and aging.
3 CONCENTRIC GEAR ALIGNMENT is assured by close tolerances between rabbet-fit assembly on gear housing and bearing bores.
4 HELICAL PLANET GEARS, meshing with integral ring gear, absorb shock loads, have long life, and operate quietly.
5 POSITIVE LUBRICATION with extra-large oil reservoir provides for long-life operation with little attention.
6 VENTILATING OPENINGS and large double-end fans make effective cooling system, permitting maximum power in minimum space.
7 OILTIGHT COVER PLATE has rabbet fit to provide proper alignment. Oil-seal on shaft retains lubricant.

These 7 features of NEW G-E gear-motors assure better operation and longer life

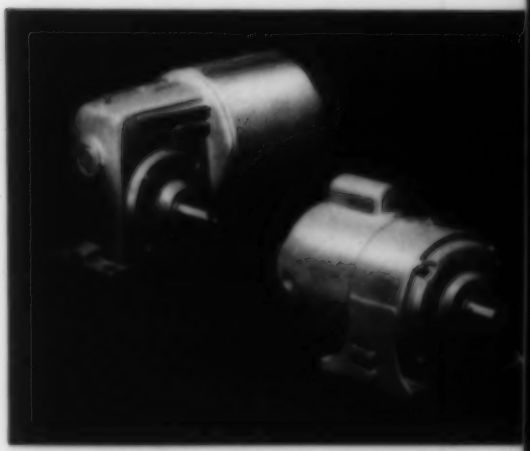
Advanced design features make new General Electric fhp gear-motors the best answer to your low-speed-drive needs. Seven top features for improved operation and longer life are described in the illustration above.

YOU SAVE 4 WAYS with these new G-E fhp gear-motors: (1) On ordering—only one unit to select instead of several. (2) On installation—unit construction saves time and trouble. (3) On space—they're the most compact low-speed drives available. (4) On operation—features mean low maintenance, long life.

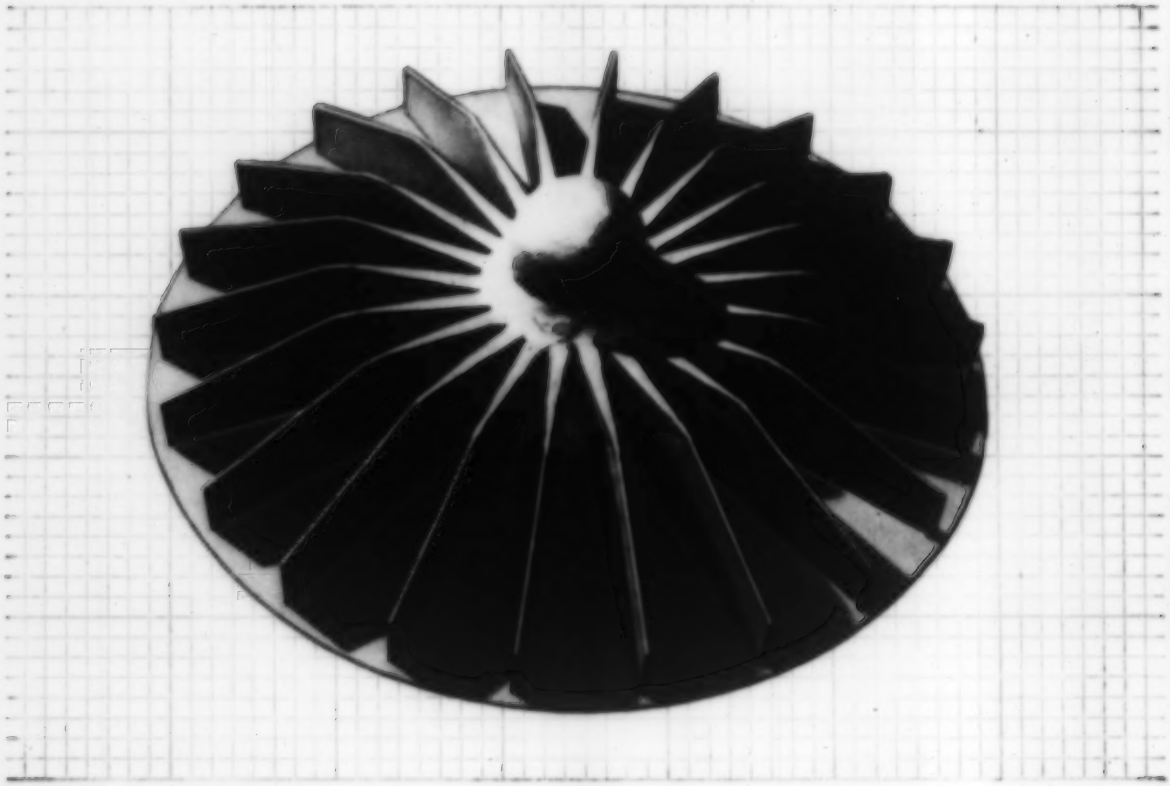
WHATEVER YOUR LOW-SPEED DRIVE NEEDS—for plant use or to power your products—you can get the right gear-motor from your G-E Apparatus Sales Office or Distributor. Ratings range from ¼ to ¾ hp, 520 to 6 rpm. Ask about "off-the-shelf" delivery on 56 popular ratings. Or write Sect. 702-17, General Electric Co., Schenectady 5, N. Y.

*du Pont Trademark
†Reg. Trademark of General Electric Co.

GENERAL ELECTRIC



BOTH RIGHT-ANGLE SHAFT and concentric-shaft models are available in the full line of new G-E fhp gear-motors. Long-life features above apply to both.



22-inch Diameter Wheels Investment Cast . . . at a 50% Saving

Turbine wheels, 22 inches in diameter and weighing close to 100 pounds, are now being mass-produced by HAYNES' precision-investment-casting process. The wheels are made of stainless steel and are used in the turbocharger section of a compressor. At one time a lengthy profile machining operation was needed to shape the intricate blades. Investment-casting eliminated this operation and cut production costs in half.

The savings realized on this wheel are typical of the many economies made possible by HAYNES' precision-investment-casting process. This modern mass-production method eliminates many machining, grinding, and assembling operations. Intricate contours, odd-shaped cavities, and thin edges can all be cast to size. Two or more parts can be designed and produced as one integral part. In most instances, an investment-cast part can be placed in operation as soon as it is delivered.

For information on how you can use HAYNES' investment-casting process to keep production costs down, write to any of the District Sales Offices listed below.

HAYNES TRADE-MARK ALLOYS

HAYNES STELLITE COMPANY

A Division of Union Carbide and Carbon Corporation

UCC

General Offices and Works: Kokomo, Indiana

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"Haynes" is a registered trade-mark of Union Carbide and Carbon Corporation.

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Clearprint Paper is WATERMARKED for your protection.

Gray iron mounting plate, for use on a water circulating pump, was cast to shape with holes cored.

Casting or steel plate ...which costs less?

This pump mounting plate when it was flame cut from hot-rolled plate and drilled, cost $1.92.

Then it was redesigned in Gray Iron

Now it costs $1.33 . . . a saving of 30%. The holes are cored and the only finishing on the casting is surface grinding on both sides.

Economy is only one reason for redesigning parts in Gray Iron. This versatile metal can give you strength, rigidity, wear and corrosion resistance . . . and many other unique engineering advantages.

Call your nearest Society member foundry and the full facilities of this association will be available to help you. Or, write direct to Gray Iron Founders' Society, Inc., National City-E. 6th Bldg., Cleveland 14, Ohio, for helpful technical and business information.

MAKE IT BETTER WITH GRAY IRON

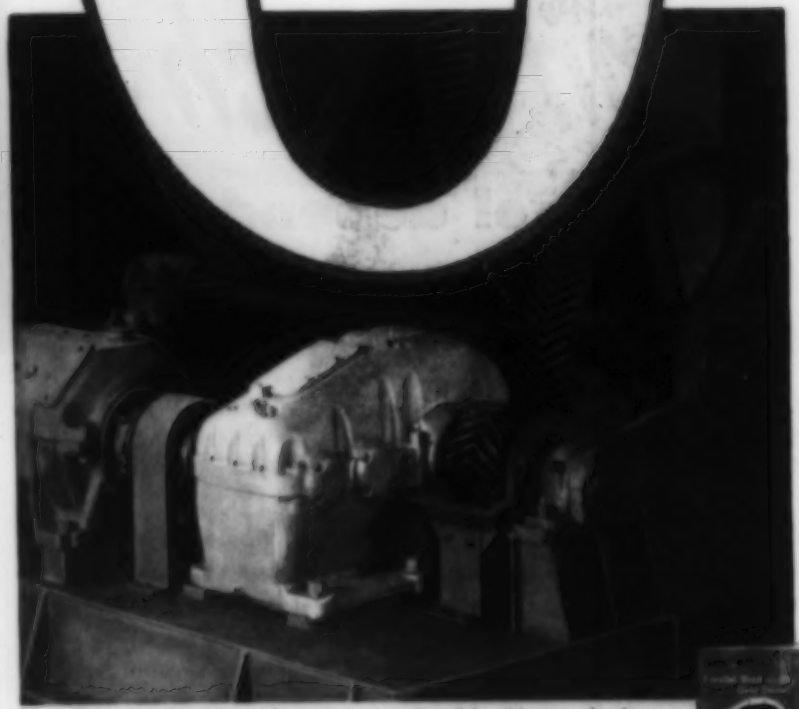
This symbol assures you the most for your casting dollar

Here's why it pays to call in one of the more than 500 leading foundries displaying the Society symbol:

- The most recent technical and business information is available to each member through the Society to help you design better products at lower cost.
- The use of sound cost accounting procedures is recommended and encouraged among Society member foundries, assuring full value for your casting dollar.
- Improved castings result from the advanced techniques and the high sense of responsibility of Society members.

GRAY IRON FOUNDERS' SOCIETY

6 reasons why Link-Belt Parallel Shaft Gear Drives ASSURE CONTINUOUS PRODUCTION



Ten-ton coils of hot strip steel are transferred by this up-ender in a modern mill. Link-Belt parallel shaft gear drive fitted with outboard bearing on output shaft withstands the exceptionally tough duty.

LINK-BELT'S compact, self-contained parallel shaft gear drives are designed to avoid common problems encountered in transmitting heavy shock loads. Here's how:

1. FOR DEPENDABLE OPERATION gears are precision-machined, shafts rigidly supported.
2. TO WITHSTAND HEAVY SHOCK and overhung loads, ball and roller bearings are used throughout.
3. TO PREVENT ENTRANCE OF DIRT and moisture, effective grease-lubricated seals are used on all shafts.
4. FOR SUPPLYING OIL to each rotating part at all speeds, automatic splash lubrication is used.
5. TO PREVENT REVERSE ROTATION on conveyors, elevators and similar equipment, a built-in backstop can be provided.
6. FOR EASY INSPECTION OR MAINTENANCE, all parts can be removed without disturbing base, which can be grouted in concrete.

Book 2619 gives complete details. Get a copy from your Link-Belt office or authorized stock carrying distributor. Or write direct.

Get JOB-MATED drive combinations from the complete Link-Belt line

In addition to parallel shaft gear drives, Link-Belt builds in-line helical and worm gear drives, Gearmotors, Motogears, variable speed drives, fluid drives, chains, sprockets, couplings, bearings, etc. All are pre-engineered for easy installation and maximum efficiency.

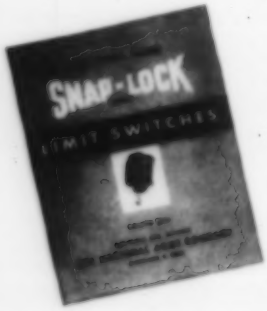
LINK-BELT

ENCLOSED DRIVES

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13.074

more than 15,000,000 contacts without 1 cent for repairs...

here's the limit switch that spells electrical control dependability in any language



Send for Bulletin EM-51 which shows various types of Snap-Lock Limit Switches available, design features, specifications, wiring diagrams, ordering data — and other National Acme electrical components and controls.

Proven stamina under all kinds of operating requirements (some installations requiring more than 400 contacts per minute) has made National Acme SNAP-LOCK Limit Switches a top-heavy favorite with both design and production engineers.

Mechanical simplicity and ruggedness are the reasons why Snap-Locks have proven an outstanding success in thousands of heavy duty equipment installations. The record shows that in many such cases, they have stood up under more than 15,000,000 contacts.

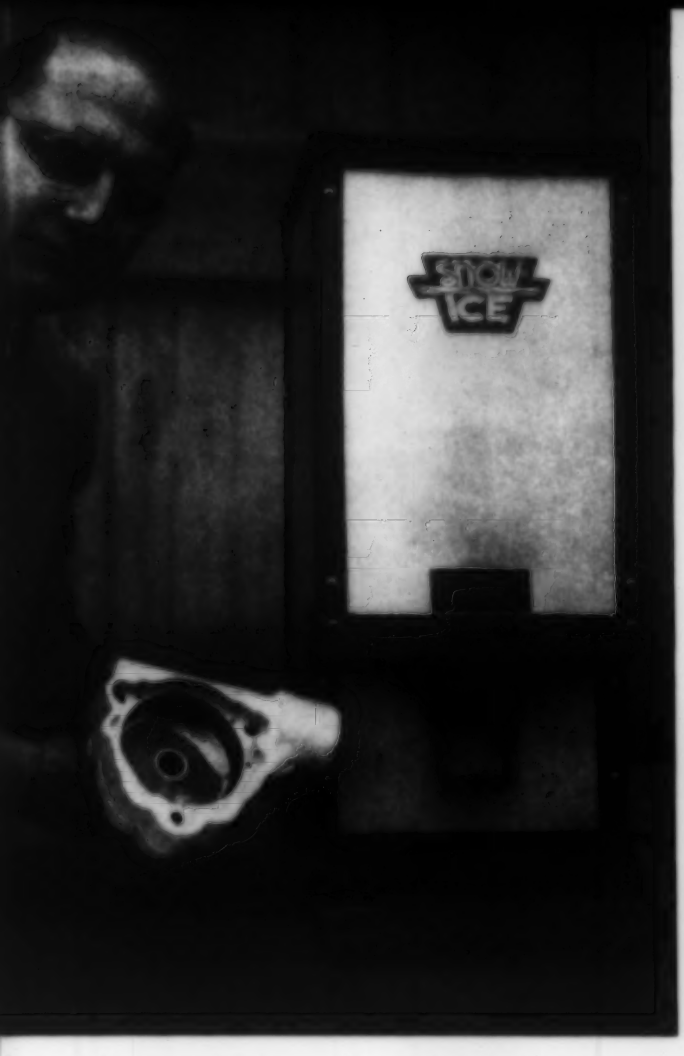
Built in a variety of sizes and designs including water resistant and special purpose types.

Ask us to assist you in designing these trouble-free switches into your equipment

ELECTRICAL MANUFACTURING DIVISION

The NATIONAL ACME COMPANY

189 EAST 131st STREET • CLEVELAND 8, OHIO



Gear case, bowl and hopper castings are insulated with a ½" thick shell of Dylite expandable polystyrene. Pre-expanded Dylite beads are placed in a mold around the castings. 270° F. steam further expands the beads, binding them tightly to the castings. The completely insulated parts are then assembled in the machine.

"It was not possible to produce this machine before Dylite* Expandable Polystyrene"

says **William L. Parsons,** *Asst. to the President, Brockman Tool & Manufacturing Co., Bala Cynwyd, Pennsylvania*

"They laughed when we wanted to make a counter type snow ice machine," said Mr. Parsons. "The almost impossible problem lay in finding an insulation that would prevent condensation from forming on the machine. We needed a material to meet these critical requirements: high insulating value, light weight, low thermal conductivity, high strength, easy moldability and production handling.

"The outstanding success of our new snow ice machines is due to the insulating performance of Dylite expandable polystyrene manufactured by Koppers."

"The use of Dylite insulation in our machines has increased the life of the ice by 100%, reduced insulation cost by 37%, eliminated troublesome condensation, minimized damage to electrical motors and wiring, prevented rust and mildew, curtailed maintenance, cut production costs, permitted a more compact package, lowered the weight and, has given us the finest, most efficient unit on the market today."

The unusual physical properties of Dylite expandable polystyrene make it perfect for all types of insulation applications. This new material is also being used for packaging, displays, toys and buoyant marine equipment. For more information send for our free illustrated booklet today. Koppers Company, Inc., Chemical Division, Dept. MD-85, Pittsburgh 19, Pennsylvania.

**Trademark of Koppers Company, Inc.*

KOPPERS

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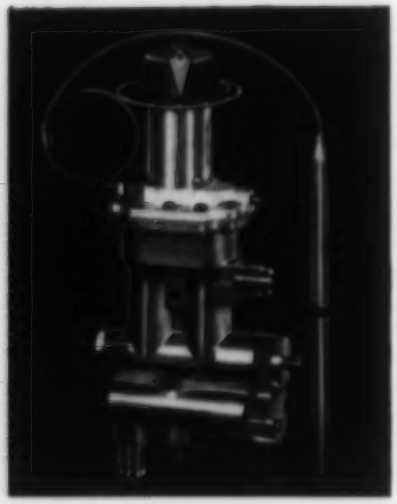
SALES OFFICES: NEW YORK · BOSTON · PHILADELPHIA
ATLANTA · CHICAGO · DETROIT · HOUSTON · LOS ANGELES

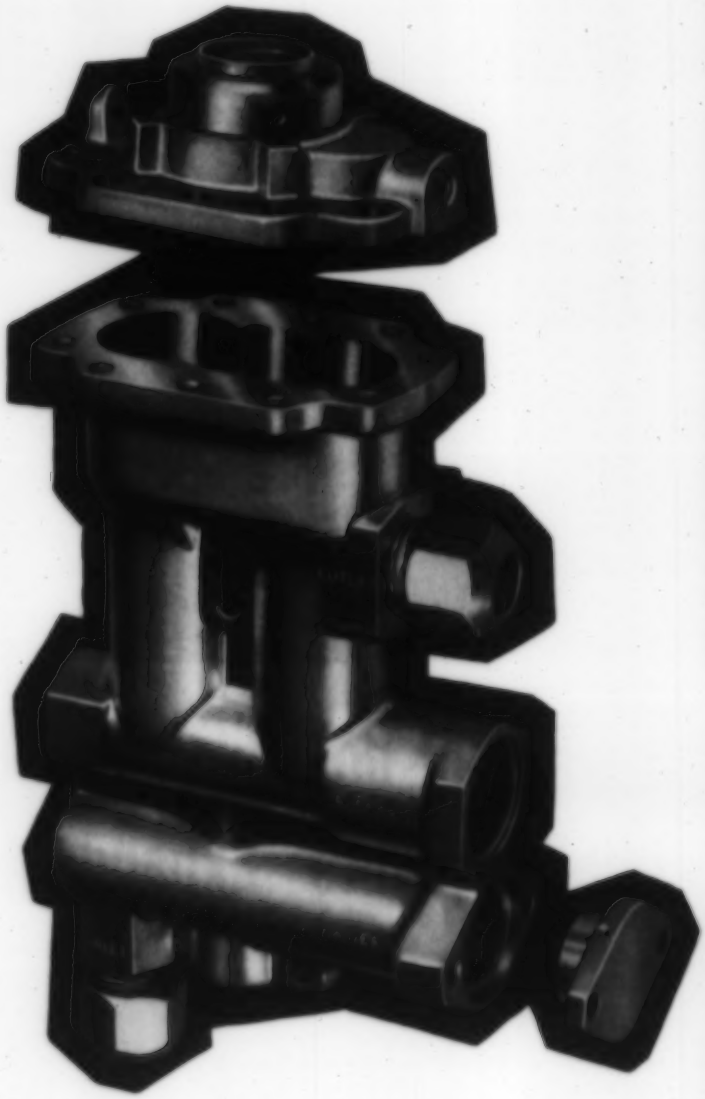
manufacture of

DETROIT SELECTAFLOW CONTROLS

greatly improved by

MUELLER BRASS CO. FORGINGS





One of the finest thermostat control mechanisms for year-around air-conditioning systems is the automatic SELECTAFLOW, a product of the Detroit Controls Corporation. To maintain the high quality of this efficient unit and at the same time speed up and simplify assembly, the body, bonnet and side cover are being forged and completely machined to close tolerances by the Mueller Brass Co. In all, thirty-four machining and finishing operations are performed. This is but one more example of how Mueller Brass Co. machined forgings have improved a product and speeded production. With a wide range of copper-base alloys for forgings, a tremendous background of product engineering, and facilities for precision finish machining, the Mueller Brass Co. can supply machined brass or bronze forgings to *your exact specifications*. It will pay you to consider Mueller Brass Co. forgings for your new or redesigned products. Write us for full color catalog and technical information.

STREAMLINE PRODUCTS

MUELLER BRASS CO.

PORT HURON 15, MICHIGAN

RUGGED AND STRONG...WINS "SPARE" DUTY

ATLAS CHAIN HAS TOUGHNESS TO "SPARE" IN BOWLING ALLEYS Offsetting the extra work involved in strikes . . . the bowling alley variety . . . are pin-setting machines, built for rough, tough usage. Especially durable are the chains and sprockets which go into them, to stand up under the frequent, sudden and often jerky motions of each pin set-up.

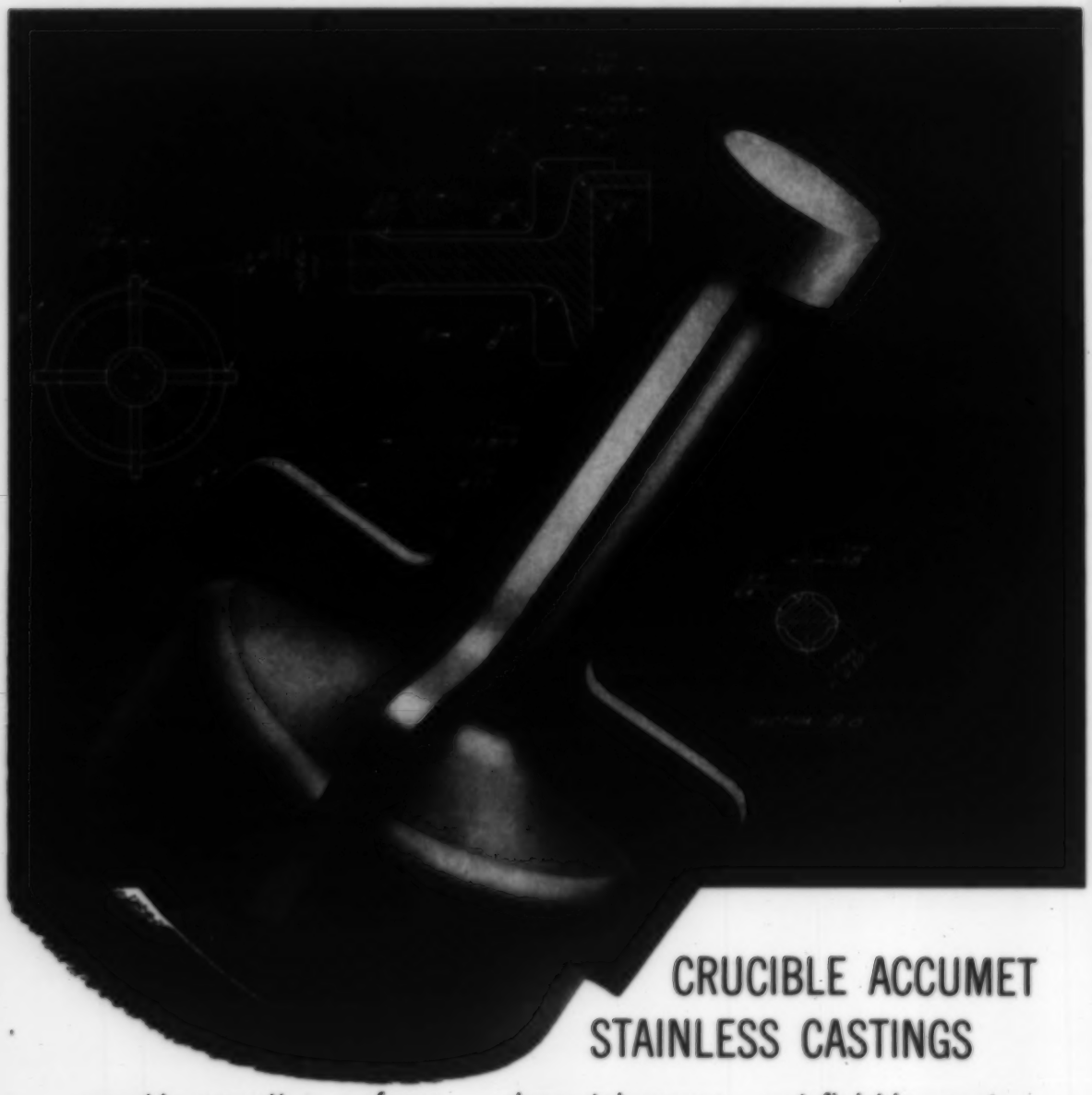
One type of pin-setting machine made by Bowl-Mor Corporation handles the candle pins shown above. In it are more than 150 feet of various type of Atlas Chain, selected because of its toughness . . . its ability to withstand the repeated shock of suddenly applied tension and equally abrupt release.

Toughness in Atlas Chain is built-in . . . first by the composition of the steel used in plates, pins and bushings . . . then by skillful heat treatment which includes the Atlas exclusive "Ni-Carb" process. Pre-testing at more than 30 production points gives assurance of chain that wears longer, requires less maintenance . . . that is unsurpassed in general overall quality and performance.

If you use chain and sprockets you will find the Atlas Handbook ARC-54 helpful. Write for a copy today.

ATLAS CHAIN AND MANUFACTURING COMPANY
DOYLESTOWN, PA.

ATLAS ROLLER CHAIN AND SPROCKETS



CRUCIBLE ACCUMET STAINLESS CASTINGS

provide smoother surfaces . . . closer tolerances — cut finishing costs

Even intricately shaped parts, like this cream separator neck piece, can be used essentially as-cast when produced by the ACCUMET method. That's because ACCUMET casting employs hot molds with special inner linings. You get castings on which thin sections are minutely defined . . . and with exceptionally fine surface finish. *Costly finishing operations are practically eliminated.*

On this stainless steel part, for example, the only finishing operations necessary are drilling and tapping of the stem section, grinding flats on the bow end, and polishing.

To minimize finishing operations on your products, consider the advantages of ACCUMET precision investment castings. Let your Crucible representative show you how their close tolerances, fine finish, and physical and metallurgical accuracy can spell substantial savings for you. And — to see what information is available on these and other Crucible special steels, write for your free copy of the "Crucible Publication Catalog." *Crucible Steel Company of America, Henry W. Oliver Building, Pittsburgh 22, Pa.*

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Crucible Steel Company of America

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Thermo Snap® CONTROLS

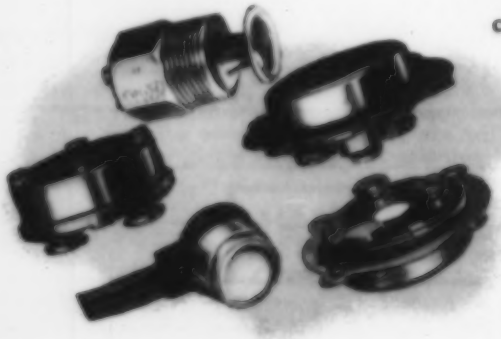
Help Cup-O-Matic Vending Machines Deliver "Sweet Milk"

The Cup-O-Matic Vendor, manufactured by Food Engineering Corporation, delivers sweet milk in paper cups in office buildings, schools, factories, etc. Every component of this bulk milk dispenser has been carefully scrutinized and field tested for dependability. That's why Food Engineering Corporation uses Klixon Thermo-Snap Controls.

Mr. J. Walter Hunsinger, Service Manager, has this to say about Klixon Controls:

> "Klixon Controls have proven completely dependable. This dependability is of the utmost importance in milk vending since the Klixon is used as a safety device to shut the machine down in the event that the temperature of the refrigerated area goes above 50 degrees F. This is essential to protect the consumer and is generally required by Health Departments . . . Our use of the Klixon has been based on its reputation as well as our own satisfactory first-hand experiences with it."

Typical Klixon Thermo-Snap Controls that can help you solve your Thermostat Control Problems



Klixon Thermo-Snap Controls are available in many hermetically sealed and open types in a wide variety of operating temperature ranges.

Klixon Engineers, specialists in temperature control applications, can help solve your specific problems. Write for their help or further information.

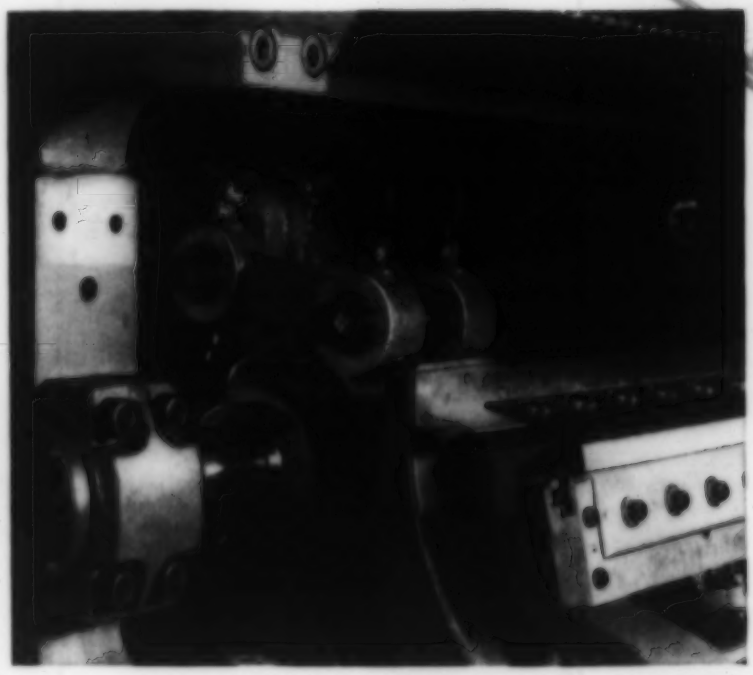
You, too, can benefit by using Klixon Thermo-Snap Temperature Controls.

KLIXON

METALS AND CONTROLS CORPORATION
SPENCER THERMOSTAT DIVISION
3208 FOREST STREET, ATTLEBORO, MASS.

P-K "proving ground" for

ASSEMBLY STRENGTH



STAY TIGHT UNDER TOUGHEST CONDITIONS

In the warp knitting machine, above, P-K Socket Screws stay tight under constant vibration. Some of many different P-K Socket Screws used are shown — P-K Cap Screws in shaft bearing pads and needle bar clamps, and P-K Set Screw in collar on needle bar rocker shaft.

The "proving ground" for the holding power of P-K Socket Screws is industry-wide. Millions of assemblies made by thousands of satisfied customers are your assurance that screws made to P-K quality standards meet every test.

In many of these assemblies, P-K Socket Screws are subjected to extreme conditions of shock and vibration . . . such as ordnance and other products made to exacting demands of the Armed Forces.

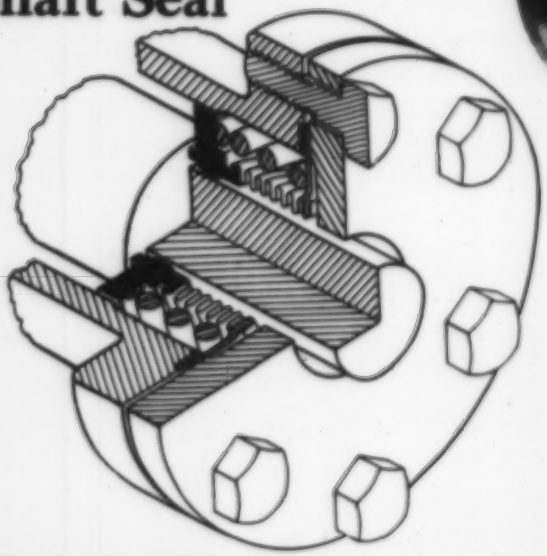
Get samples, information from your P-K Distributor, or write: Parker Kalon Division, General American Transportation Corporation, 200 Varick St., New York 14.

PARKER-KALON

SOCKET SCREWS

Remember P-K means **OK**

How To Design A Bellows Type Shaft Seal



BELLOWS SHAFT SEAL ASSEMBLY is mechanically attached and sealed to shaft housing on one end. Seal nose at other end bears against shoulder on rotating shaft. The bearing surface of seal nose can be superfinished. Thrust is maintained by spring-action of the bellows, backed up by loading spring and remains constant regardless of pressure changes. Result: power output of shaft does not vary with pressure changes within the system. Wear occurs at an even, low rate. No tightening or take-up is required for the life of the seal.

Advantages of Bellows Seals

Pressure Problems Metallic bellows shaft seals have a long history of successful application in sealing shafts operating under fluid pressure conditions. A common example is their use in sealing the pump shafts of high pressure refrigeration systems.

By designing the seal nose and bellows to have equal effective areas, the thrust of the seal against the shaft face will remain constant and at a low value. Changes in internal or external pressures have no effect on the power output of the shaft and a tight seal is maintained.

Temperature Applications The all-metallic construction of bellows shaft seals make them effective over wide temperature ranges. In aircraft applications, bellows type seals operate under temperature extremes of —20F to 165F in pump shaft service. Even greater temperature ranges than these pose no problems for bellows shaft seals since they are not subject to deterioration due to heat and cold.

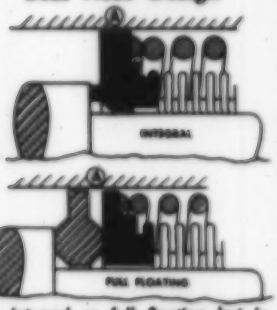
Shock, Vibration, Misalignment problems are frequently overcome by these seals because the bellows are inherently flexible and when a back up spring is incorporated in the design, they are ideal for such heavy duty applications as sealing torque converter shafts on trucks, military tanks and other large equipment operating under severe load conditions.

Corrosion Bellows shaft seals made of corrosion resistant metals such as stainless steels, monel, etc., greatly minimize corrosion problems. Several major manufacturers use them for sealing the shafts of gasoline and fuel pumps.

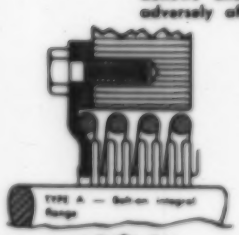
Shaft Preparation

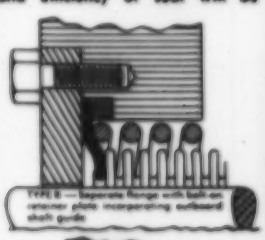
The shaft to be sealed may either be turned down to provide a face for the seal nose to bear against, or a built-up ring may be provided. In either case the shaft face should be suitably finished for the intended service. (7.4.12)

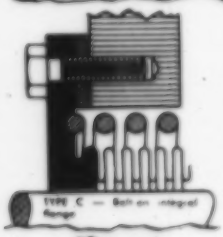
Seal Nose Design

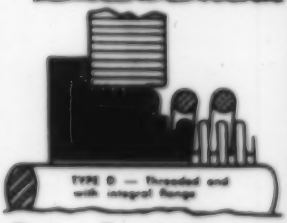


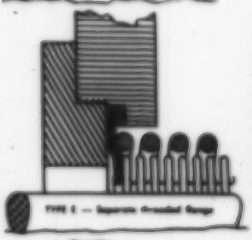
Seal nose can be integral or full floating but in either case guide the nose piece from the stationary member (shaft housing) as shown at (A). Full-floating design is best. It is poor practice to guide seal nose from shaft since vibration will be transmitted to bellows and life and efficiency of seal will be adversely affected.





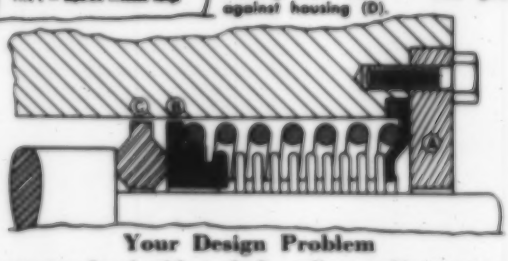






Design Requirements

The outboard end of the shaft seal must always be fastened rigidly to the stationary shaft housing and gasketed leak tight. Bellows should never be allowed to rotate with the shaft. Composite of good practice (below) shows use of an outboard shaft guide (A), nose piece guided against stationary housing (B) and use of full floating seal nose — also guided against housing (D).



Your Design Problem

If you are faced with a shaft sealing problem, you can get help direct from Clifford. Simply sketch the controlling dimensions, types of seal ends desired and service conditions to be met. We will recommend a design to meet your requirements and produce seals in any quantity.

Write: Clifford Manufacturing Company. 124 Grove Street, Waltham 54, Massachusetts. *Division of Standard Thomson Corporation.* Sales Offices in New York, Detroit, Chicago, Los Angeles and Waltham, Mass.

CREATIVE DESIGN

They Pumped Live Fish . . . to Prove a Point

When Design Engineers at Fairbanks-Morse perfected the non-clogging pump, they pumped live fish to prove its non-clogging performance. For they knew that if they eliminated the restricted passages that cause expensive pump clogging, they could even pump live fish, whole and undamaged.

The result of that Project is the now famous F-M pump that provides non-clogging service for the food industry, municipal authorities and industrial waste engineers.

Only from Fairbanks-Morse can you get the originality and soundness of *new* design that assure such outstanding performance. When next you need a pump . . . or a scale . . . an electric motor . . . or a diesel engine . . . look for the famous F-M Seal and see the difference that quality makes. Fairbanks, Morse & Co., 600 So. Michigan Avenue, Chicago 5, Illinois.

The Secret of F-M non-clogging pump performance is this unique impeller design that permits pumping all solids in suspension—even fish.

The Result is that on installations, like this food processing line, money formerly wasted on pump maintenance due to clogging is now saved.

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a name worth remembering when you want the best

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Ross Exchanger safeguards total pressure of this new 100-ton Kux Powder Metal Press

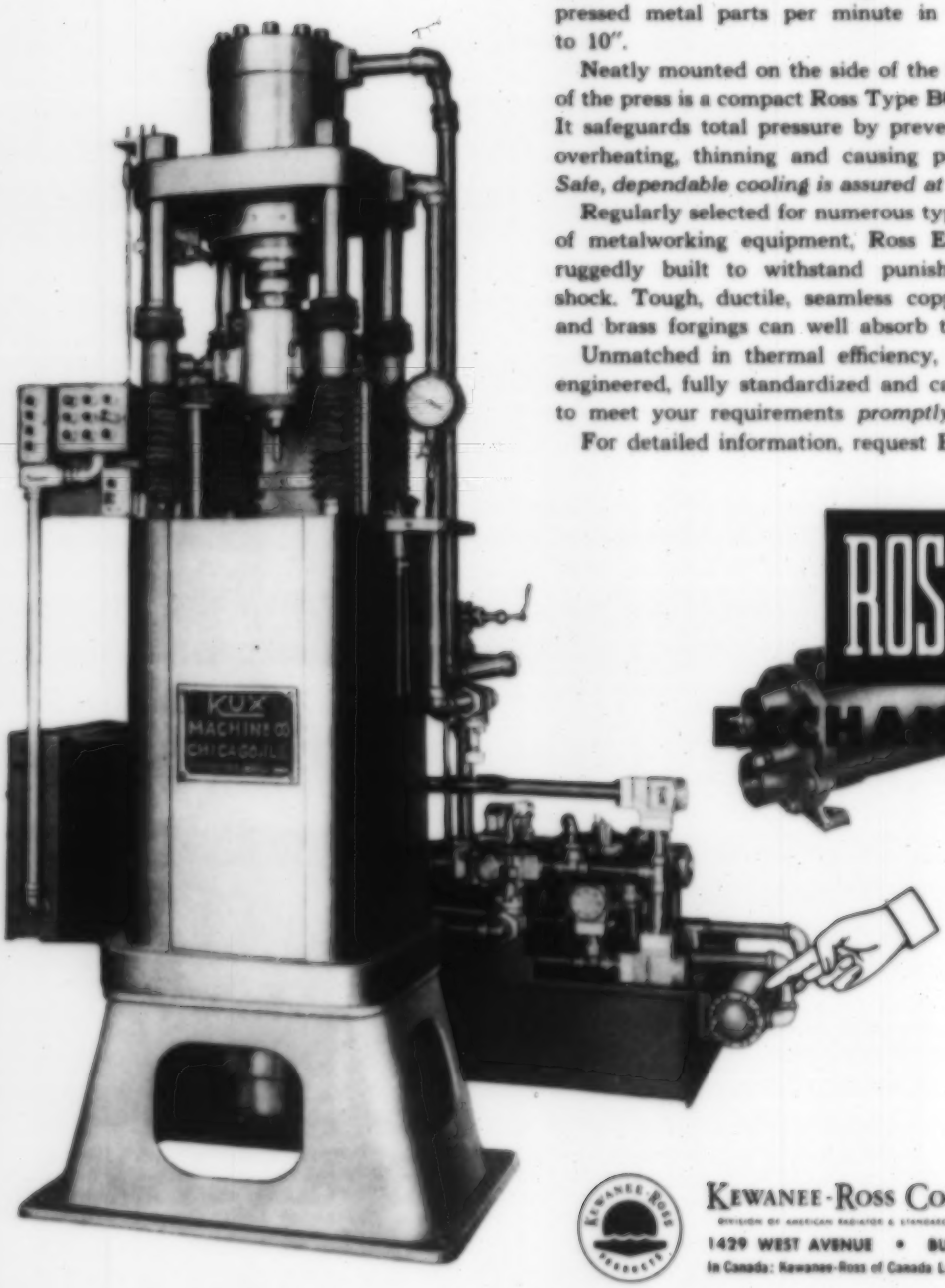
Featured as a *new* press in the Kux "Big 4 Hydraulic Series," this 100-ton Kux Powder Metal Press (Model 4100) has been designed to form 15 compressed metal parts per minute in diameters up to 10".

Neatly mounted on the side of the hydraulic unit of the press is a compact Ross Type BCF Exchanger. It safeguards total pressure by preventing oil from overheating, thinning and causing pump slippage. *Safe, dependable cooling is assured at all times!*

Regularly selected for numerous types and makes of metalworking equipment, Ross Exchangers are ruggedly built to withstand punishing hydraulic shock. Tough, ductile, seamless copper-alloy shell and brass forgings can well absorb the extra load.

Unmatched in thermal efficiency, they are pre-engineered, fully standardized and carried in stock to meet your requirements *promptly*.

For detailed information, request Bulletin 1.1K5.



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At the Mass. Institute of Technology Machine Tool Laboratory the effect of variables such as cutting field, tool geometry, speed and feeds, and tool material are measured and recorded, using a dynamometer and Sanborn two-channel System. Such records for various lathe operations, as well as many other cutting operations, provide valuable insight into the whole metal cutting process.

. . . from lathe cutting forces to telemetered aircraft data . . .

SANBORN Oscillographic RECORDING SYSTEMS prove their versatility

At Moore Products input and response of their Valve Positioner, a pneumatic instrument widely used on diaphragm top-work valves and power cylinders, are recorded on a Sanborn two-channel System. Impulses from a pneumatic sine wave generator, of frequencies as high as 20 cps, are fed through a transducer in one channel, with valve stem response recorded by the second channel from a strain gage pickup.

At Edwards Air Force Base, California, this U. S. Air Force telemetering van received and recorded information transmitted from various pickups and transducers in the new delta wing Convair YF-102A during flight. Photos of van interior show eight Sanborn four-channel recording systems in rear, and close-up of four of the systems. Thus equipped, the van could receive data which would affect the design and performance of the YF-102A, a faster-than-sound, all-weather interceptor built by the Convair Division of General Dynamics Corporation.

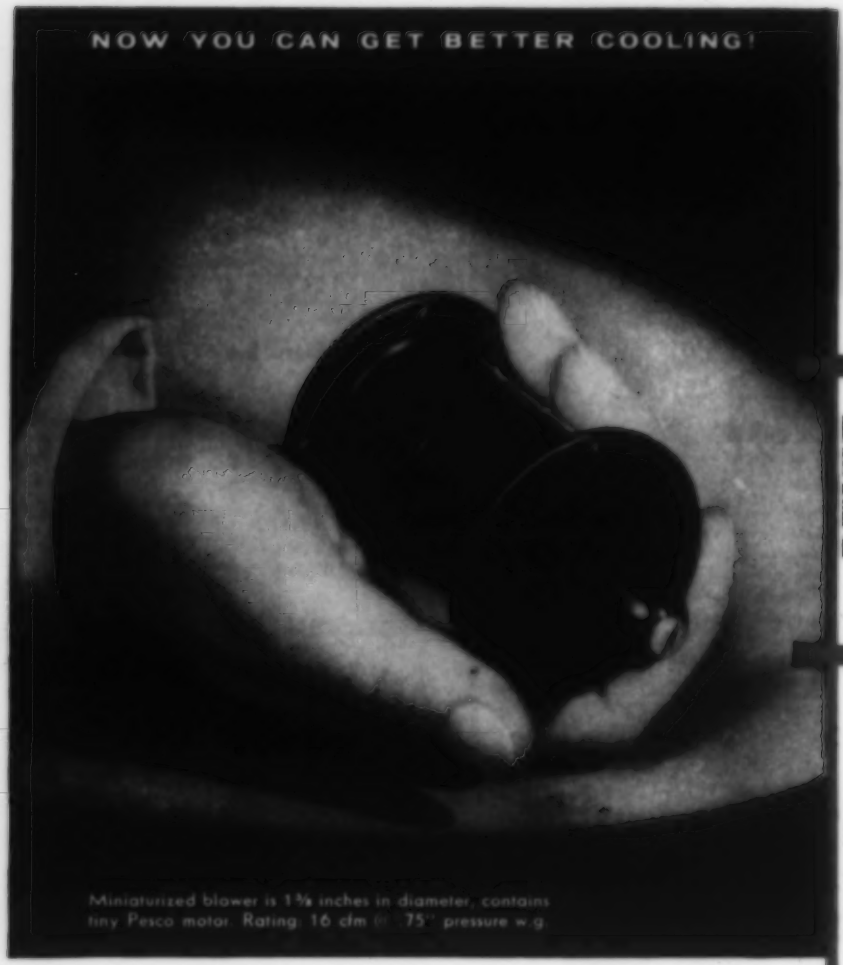
hese typical two- to 32-channel applications of Sanborn oscillographic recording systems give an indication of the tremendous scope of this versatile equipment. Elsewhere, Sanborn 1-, 2-, 4-, 6- and 8-channel systems and components are used in meteorological research . . . quality control programs . . . instrument and machinery field testing.

Flexibility of Sanborn design permits interchangeable amplifiers and preamplifiers to meet *individual* recording requirements with greater over-all efficiency and economy. Other Sanborn features include *inkless* recording in true rectangular coordinates, high torque galvanometer movement, time and code marking, and numerous chart speeds.

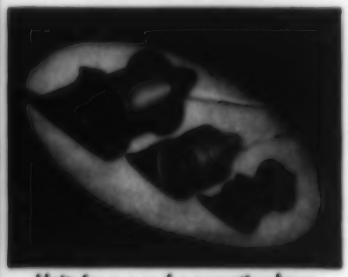
CATALOG AND TECHNICAL DATA AVAILABLE ON REQUEST

SANBORN COMPANY

INDUSTRIAL DIVISION
CAMBRIDGE 39, MASS.

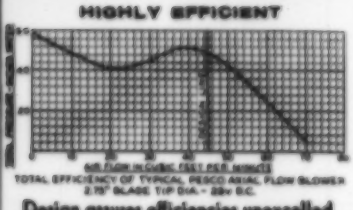

NOW YOU CAN GET BETTER COOLING!
Miniaturized blower is 1⅝ inches in diameter, contains tiny Pesco motor. Rating: 16 cfm @ .75" pressure w.g.

COMPLETE LINE



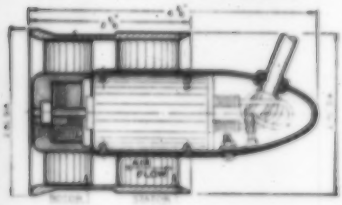
Units for a-c or d-c operation have capacities from 16 to 750 cfm.

HIGHLY EFFICIENT



Design assures efficiencies unexcelled in comparable "package" sizes.

LIGHTWEIGHT, COMPACT



High air displacement and pressure achieved with minimum size and weight.

new Pesco axial flow blowers

More efficient air delivery or exhaust is possible with the new Axial Flow Blowers now manufactured by PESCO. Engineered by a leading British firm, these advanced design blowers have been proved under tough service conditions. They provide better cooling, heating or ventilating for a wide variety of aircraft and industrial applications.

PESCO® Axial Flow Blowers are self-contained package units which save space and permit more flexible product design. They incorporate a rotor direct coupled to a PESCO Electric Motor for efficient air flow.

An outstanding characteristic of this new PESCO product is the high capacities obtained with minimum power. Careful aerodynamic design assures optimum efficiency with axial air flow. PESCO Blowers withstand severe conditions of shock, temperature, pressure, altitude, humidity and duty cycle. Rated for continuous operation at high ambient temperatures, they perform in any position. Dynamic balancing assures quiet, vibration-free operation. Flange or clip mounting is optional.

Before you proceed with the design or re-design of any equipment requiring localized heating or cooling, investigate the better performance now possible with PESCO Axial Flow Blowers. For complete details, contact your local Pesco representative or write: PESCO, 24700 North Miles Road, Bedford, Ohio.

engineering Pesco production

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WANTED

Technical Editors

■ Expanding needs of the design engineering profession have created a need for enlarging MACHINE DESIGN's editorial staff. Two additional assistant editors are needed now.

■ One should have design engineering background, preferably an ME or EE degree plus experience as a designer.

■ The other may have journalism or writing background in lieu of an engineering degree but should have some engineering work experience or engineering schooling.

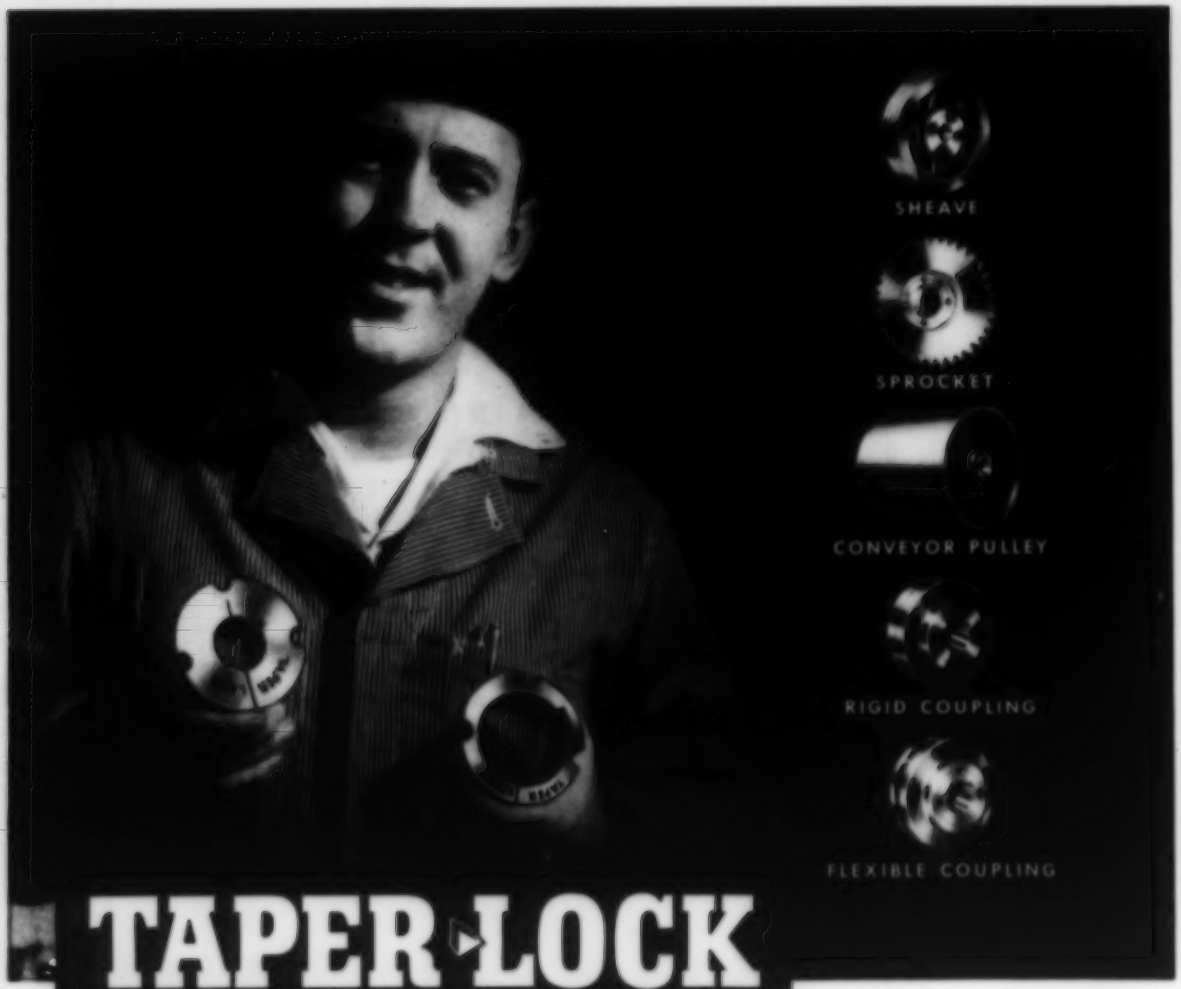
■ Both should be able to write fluently and well and should possess a keen interest in helping to disseminate information of practical value to MACHINE DESIGN's 100,000 design engineering readers.

■ Assignment is to procure, select, write and edit articles and feature departments.

■ Headquarters are in Cleveland, with opportunities to travel in quest of editorial material.

■ This is a real challenge to men with enthusiasm for both engineering and writing coupled with a strong creative urge.

■ If you are interested and feel qualified, please send full details of your engineering and writing experience to the Editor, MACHINE DESIGN, Penton Building, Cleveland 13, Ohio.



"Brother...you sure can save with these interchangeable bushings!"

With a few Taper-Lock bushings you can make quicker changes and cut down-time on production machines—because Taper-Lock bushings are *interchangeable*. Shift from a Dodge sprocket to a Dodge sheave, and use the same bushing! Taper-Lock bushings are available in a range of sizes which makes changing from one size shaft to another equally easy and quick.

Mount 'em all with Taper-Lock bushings—your sheaves, sprockets, couplings, conveyor pulleys. They slip on the shaft quickly—hold with the firmness of a shrunk-on fit—come off easily without shock to bearings or machinery. Standardize, economize with Taper-Lock.

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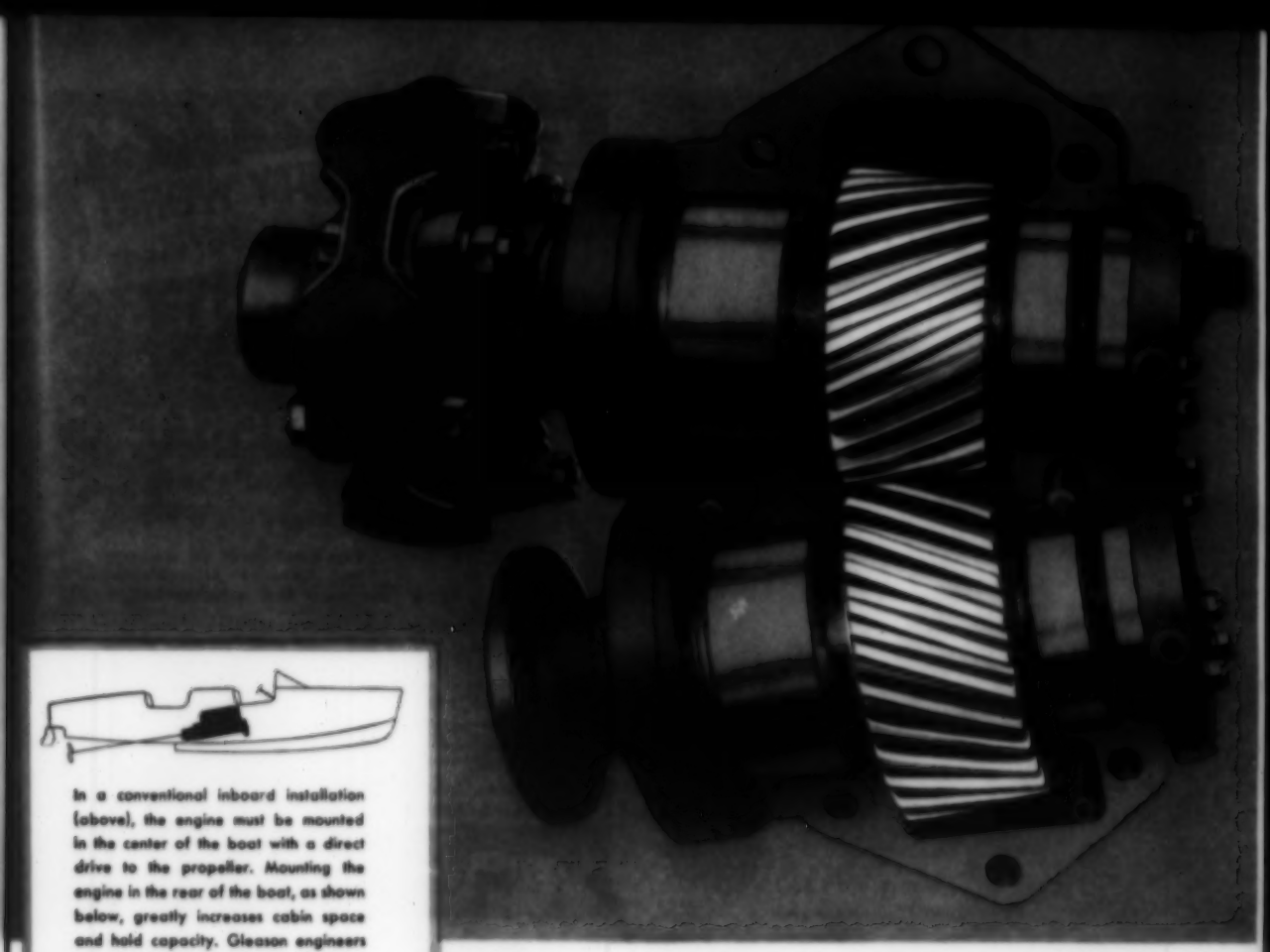
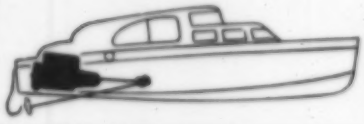
CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable assistance on new, cost-saving methods. Look for his name under "Power Transmission Machinery" in your classified telephone directory, or write us.

THERE'S ONLY ONE TAPER-LOCK, THE BUSHING THAT MOUNTS FLUSH!

DODGE
of Mishawaka, Ind.



In a conventional inboard installation (above), the engine must be mounted in the center of the boat with a direct drive to the propeller. Mounting the engine in the rear of the boat, as shown below, greatly increases cabin space and hold capacity. Gleason engineers assisted the Marine Engine Manufacturers in the development of the V-Drive.



Angular power transmission can improve *your* product, too

Take, for example, this marine V-Drive. The use of spiral bevel gears permitted a design which released more usable space in the boat, improved balance, and simplified installation.

This is just one instance of the added flexibility of product design possible with angular power transmission.

Faster production and lower costs will also result from using this type of transmission.

If you have a design application for bevel or hypoid gears, the Gear Engineering Department of the Gleason Works is ready to help you realize every advantage possible. Design and production recommendations for your angular drive are offered at no obligation.

If you would like to discuss your bevel gear application with a Gleason representative, please contact us.

These Gleason Technical Handbooks are available on request:

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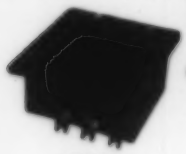
P-506-CE—Plug with Cap


S-506-DB
Socket with deep Bracket

JONES PLUGS & SOCKETS
500 SERIES
Proven Quality!

For 5,000 Volts, 25 Amperes per Contact Alterable by circuit Characteristics.

Socket contacts of phosphor bronze, knife-switch type, cadmium plated. Plug contacts hard brass, cadmium plated. Made in 2, 4, 6, 8, 10, and 12 contacts. Plugs and sockets polarized. Long leakage path from terminal, and terminal to ground. Caps and brackets, steel parkerized (*rust-proofed*). Plug and socket blocks interchangeable in caps and brackets. Terminal connections most accessible. Cap insulated with canvas bakelite.

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(leading to Vice-Presidency)

Outstanding opportunity with well-established manufacturer of heavy precision equipment in Philadelphia area to head up a well-rounded engineering department of 50 people in all phases, including research and development. Must have experience in heavy machinery design, plus executive responsibilities. Also require working knowledge of large machine shop operation.

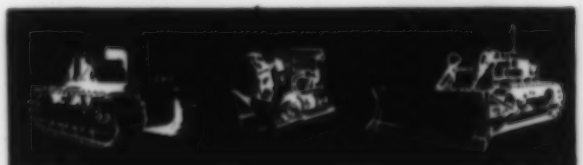
A qualified candidate must possess administrative ability, analytic sense, imagination and ingenuity, all proved by his record.

Age limits: 42-50. Engineering degree required —ME preferred.

Salary open, plus attractive profit sharing.

There is a real career here for the right man.

Send full details in complete confidence in writing through our advertising counsel by addressing Department 5081, Albert Frank-Guenther Law, Inc., 2006 Packard Bldg., Phila. 2, Pa.



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Earthmoving experience, with successful record in design and development of heavy mechanical equipment, crawler tractors, bulldozers, winches and attachments.

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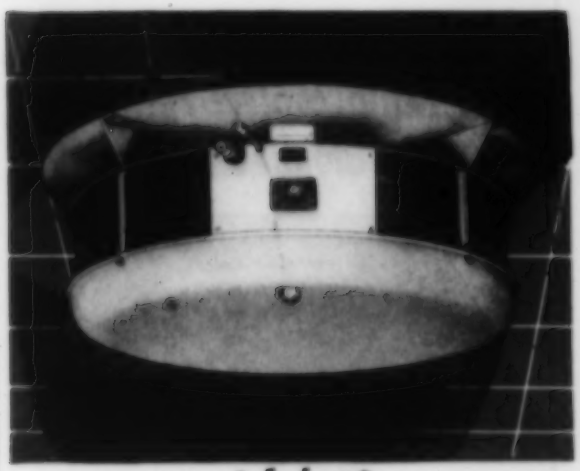

DOERR Motors solve problem on Bush Jet Coolers

Ceiling Jet Unit Coolers, a product of the Bush Manufacturing Company, of West Hartford, Connecticut, have the responsible job of maintaining continuous low temperatures in cold storage rooms. This calls for reliable motor operation, usually in the presence of high humidity.

The Doerr 1/10 hp, 1140 rpm, Type C, permanent split capacitor motor selected had to be suitable for replacement in existing units in the field. The band mounting used restricts the frame diameter and height is also at a premium. The unusual method shown for mounting the capacitor provided the answer and has simplified assembly in both production and in servicing.

This is another instance where Doerr has helped with a special design. If you have an unusual motor problem, please let us hear from you.

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DOERR
Electric Corporation
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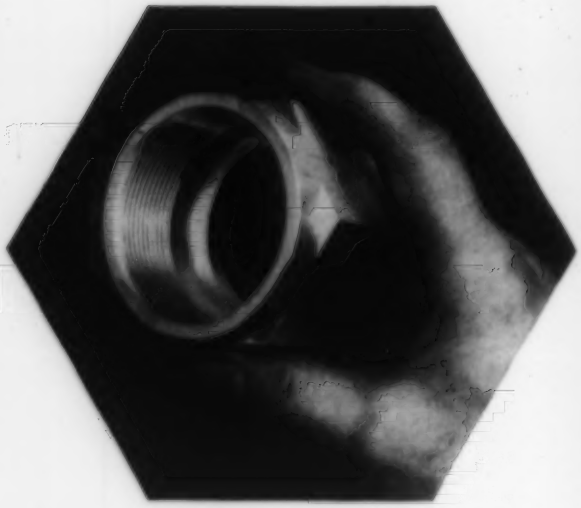
Electric Motors from 1/30 to 5 hp. Standard or designed to your specifications.

There is a right method of chip control for this aluminum part



Alcoa offers the answers here...

On many screw machine jobs there are operations which can be done in different ways, but, there is usually just one "best" way. To supplement your own experience, Alcoa offers users of Alcoa® Aluminum Screw Machine Stock a complete technical packet containing: calculators for feeds, speeds and properties; an engineering handbook on machining aluminum; a booklet of corrected tool diameter tables; case histories of savings; a conversion chart for alloy designations. The complete packet is free for the asking. Just fill out and mail this coupon today.

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873-H Alcoa Building, Pittsburgh 19, Pa.

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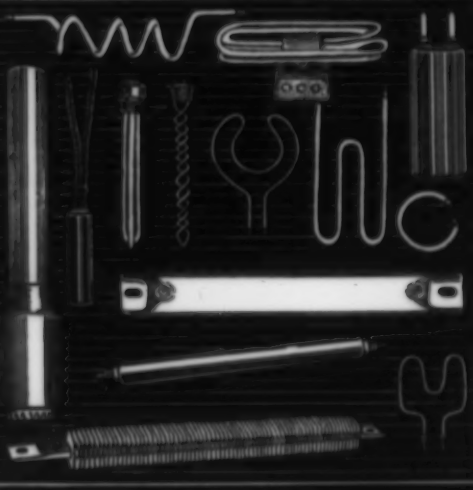
ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

VULCAN

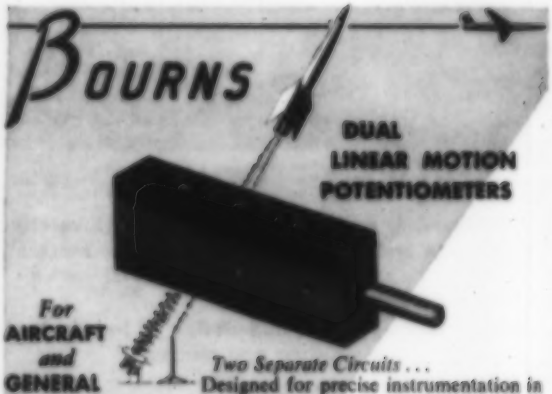
ELECTRIC HEATING UNITS



VULCAN ELECTRIC CO
DANVERS MASS

BOURNS

DUAL LINEAR MOTION POTENTIOMETERS



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Designed for precise instrumentation in automatic control circuits for aircraft, guided missiles and general industry, BOURNS linear motion potentiometers accurately translate mechanical position or movement into two independent signals . . . one signal often used for feed-back control and the other for telemetering.

This dual instrument possesses all the advantages of two single potentiometers and in addition, saves space, weight and installation time. With this wire-wound potentiometer a resolution of .001 inch is obtainable in standard ranges from 1 to 6 inches.

BOURNS designs and manufactures other potentiometer instruments which measure gage pressure, differential pressure, altitude and acceleration.

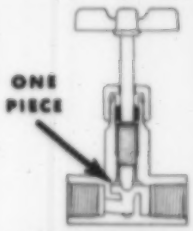
BOURNS LABORATORIES
6135 Magnolia Avenue, Riverside, California
Technical Bulletin on request, Dept. 159

New MARSH Needle Valves

MAXIMUM WORKING PRESSURE 10,000 PSI

. . . for finer regulation of water, oil or gas

First needle valve to combine all the characteristics called for in modern industry. Embodies sturdiest basic construction—machined from solid bar stock—suitable for pressures to 10,000 psi and equally efficient in lower range. Note stem guide fused to body by new "Conoweld" process, eliminating faults of conventional two-piece valves. Stem 416 stainless steel. Stem threads fine pitch for strength and micrometer regulation. Body electro-zinc plated. Sizes ⅛" to 1", globe and angle patterns.



Ask for new Needle Valve Catalog

MARSH INSTRUMENT CO. *Sales Affiliate of Jas. P. Marsh Corp.* **Dpt. S, Skokie, Ill.**
Marsh Instrument & Valve Co. (Canada) Ltd., 9407 103rd Street, Edmonton, Alberta, Canada

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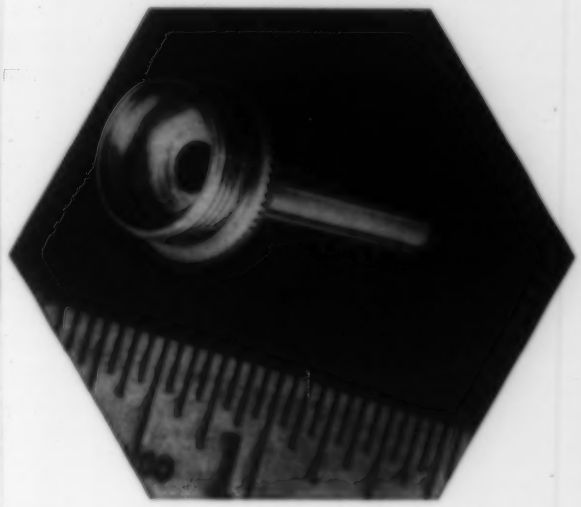
There is a right way to thread and tap this aluminum part



Alcoa offers the answers here...

On many screw machine jobs there are operations which can be done in different ways, but, there is usually just one "best" way. To supplement your own experience, Alcoa offers users of Alcoa® Aluminum Screw Machine Stock a complete technical packet containing: calculators for feeds, speeds and properties; an engineering handbook on machining aluminum; a booklet of corrected tool diameter tables; case histories of savings; a conversion chart for alloy designations. The complete packet is free for the asking. Just fill out and mail this coupon today.

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CHANGES HI-SPEED INTO HI-TORQUE

Rugged, compact, precision gear train component, changes high speed into high torque at low speed. Continuous long term torque output ranges to 1000 in. oz., and for short periods this may be greatly exceeded. Basic unit diameter is 1⅛" with ⅜" dia. input shaft, and ½" dia. output shaft. Length depends on any of standard speed reduction ratios from 18.78 to 1, to 21,808 to 1. Write today for information on Globe Integral Planetary Gear Reducers.

Furnished with flange or above base mounting.

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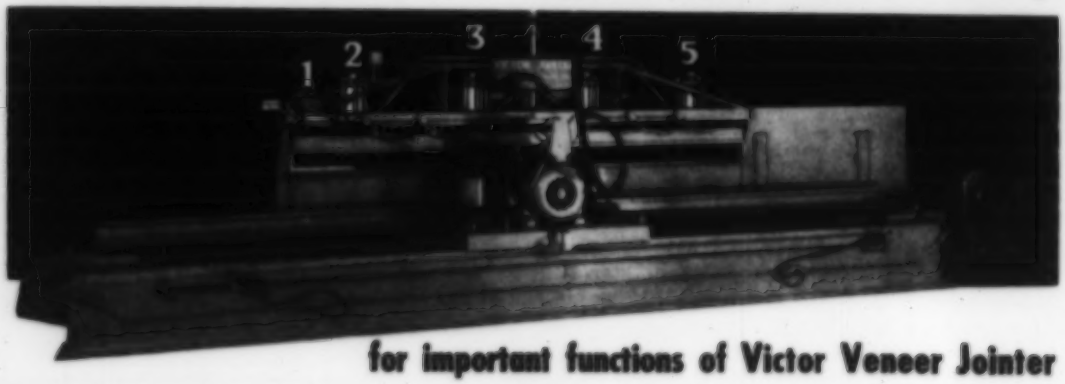
5 NOPAK Cylinders supply pressure and pull



for important functions of Victor Veneer Jointer

The Victor Straight-Line Veneer Jointer, built by the E. V. Prentice Co., Portland, Ore., employs a NOPAK Model E 2½" x 6" Cylinder to operate the stops which align the stock, and 4 NOPAK Model D, 6" x 5" Cylinders to exert adequate, equalized clamping pressure on the full length of the stock to be joined. All cylinders are controlled from a single station to provide for fast precision alignment and clamping in a rapid, repetitive work cycle.

This is another example of the important role played by NOPAK Cylinders and Valves in actuating and controlling precision machine movements. Others are shown in the NOPAK Application Manual. Ask your NOPAK Representative to show you this helpful book.

Refer to Classified Section of your Telephone Directory for name of nearest NOPAK Representative.

GALLAND-HENNING NOPAK DIVISION
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NOPAK
VALVES AND CYLINDERS
DESIGNED for AIR and HYDRAULIC SERVICE

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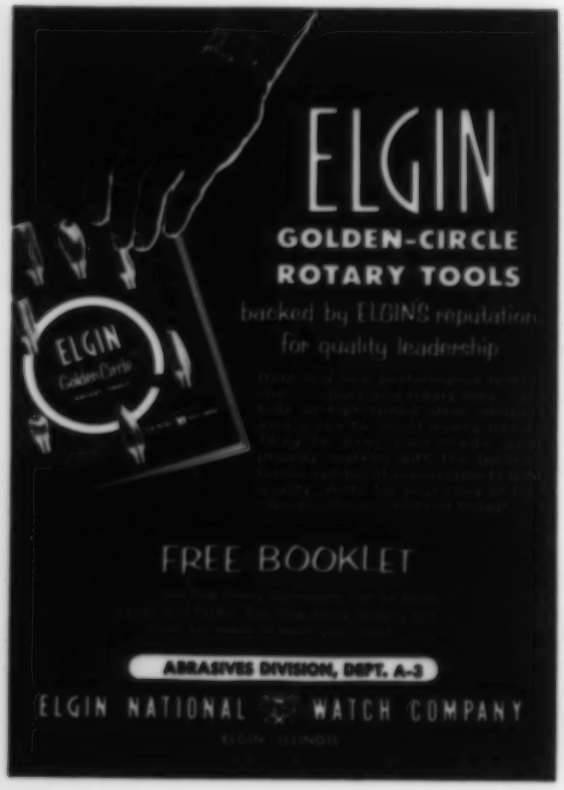

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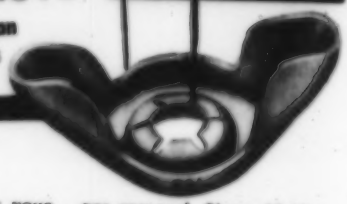
WING NUTS
cost less than ordinary types

Built-in spring locking action holds tight until finger-released



An extra value for your customers—a real saving for you. Precision, spring steel PALNUT Wing Nuts spin on freely—lock securely when finger-tightened—stay tight in service—unlock with finger removal. Sizes: #6-32, #8-32, #10-32, #10-24, ¼-20 and ⅜-18. Finishes: cadmium, nickel, chrome or others to order. Send for free samples, stating sizes required.

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PALNUT
LOCK NUTS

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GEARS...—no stocks—96 pitch to 5/7 D.P.—¼" P.D. to 18" P.D.—custom cut from any gear material.

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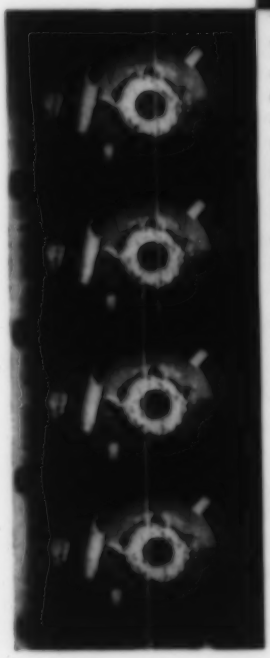
High-Speed Cine-Oscillographic Cameras

8 mm - 16 mm Cameras with 400 ft. capacity ...speed ranges from 500 to 18,000 pictures per second.



With the new combination cine and oscillographic camera there is a simultaneous recording of visual and electrical phenomena. The oscilloscopic image is superimposed over the motion picture image on the emulsion side of the film. Thus a permanent record is available for study and measurement.

New features:

- Lenses in focusing mount with bayonet attachment.
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- Can be used either as a high-speed motion picture, streak or combination camera.

WRITE for more detailed information and prices.

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For years, we have studied the nature of friction; this independent basic research produced Rulon—oil-free bearing material for light loads, or heavier loads at slower RPMs and with inherently low friction coefficient, that never needs lubrication.

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RULON

Bearing Material:

Attributes: More than 14 unusual characteristics.

Applications: Countless practical uses, others as yet unexplored.

Data: 20 Data Sheets with full information, case histories.

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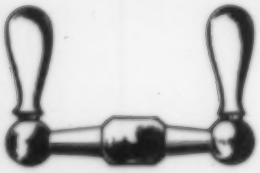
HIGH QUALITY AT MODERATE PRICES!

Balanced Cranks, Compound Rests and Clamping Levers



COMPOUND RESTS WITH TWO HANDLES

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Machined from solid bar steel and polished to smooth high lustre.

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Also solid web. Fine grain cast iron. Rims and handles polished to high lustre. Many sizes.

Ball Handles — Threaded

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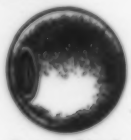

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Made in a wide variety of diameters and threads. Steel ball handles are highly polished.

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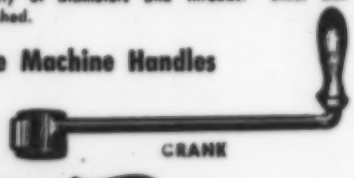

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STRAIGHT

Also offset types in a wide variety of sizes. Smooth finish. Low in price.

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Please send me FREE 56 page catalog, illustrating and describing the REID line of necessary and hard-to-get components and accessories.

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use a **GRIPCO LOCK NUT**

- To Hold Tighter
- To Last Longer
- To Cost Less

in these and hundreds of other applications where stress, wear or vibration is a factor. The Gripco Lock Nut, with its simple, one-piece design, has given industry a tighter, more positive holding action for quicker fastener application at less initial cost. No inserts, outside devices or complicated features – the Gripco Lock Nut holding or locking action is inherent in the nut itself – it costs less to use, gives an easier, faster locking and holds tighter for a longer time. Impervious to oil or water. For faster production, lower manufacturing and maintenance costs, look into the Gripco Lock Nut today.

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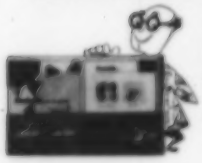

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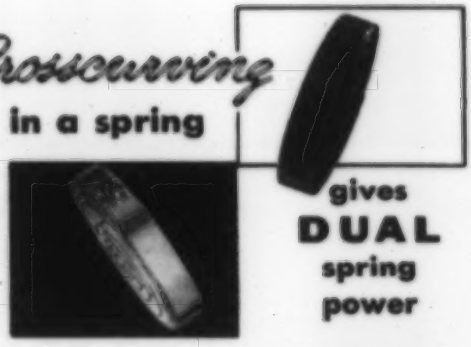
Crosscurving in a spring



gives **DUAL** spring power

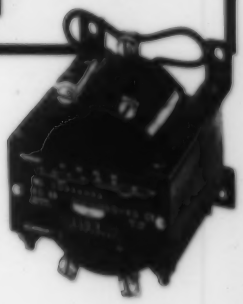
You get Dual Power when you use Sandsteel's "Crosscurved" mainsprings in your products. The "Crosscurved" spring tends to expand in the direction in which it is tempered and the crosscurve, which at full wind is partly flattened out, stores additional energy. You get more energy per wind and a smoother, more even energy distribution. This results in superior performance, greater accuracy and longer life for your product. The "Crosscurved" mainspring is original with Sandsteel — means better engineering . . . greater efficiency. Investigate the possibility of using Sandsteel "Crosscurved" mainsprings in your product. We shall be pleased to advise you.

Write for FREE LITERATURE and CASE FILE. Dept. 13

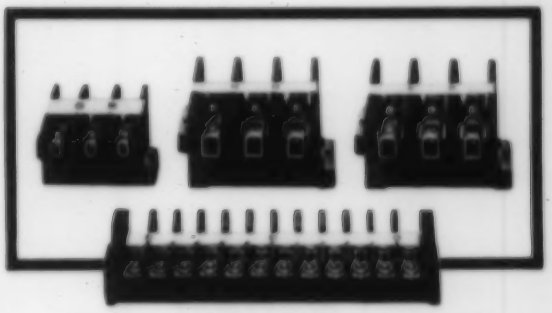
SANDSTEEL SPRING DIVISION
SANDVIK STEEL, Inc.
FAIR LAWN, NEW JERSEY

CUTLER-HAMMER
CONTROL Transformers

TRANSFORMERS BUILT SPECIFICALLY FOR USE ON CONTROL CIRCUITS



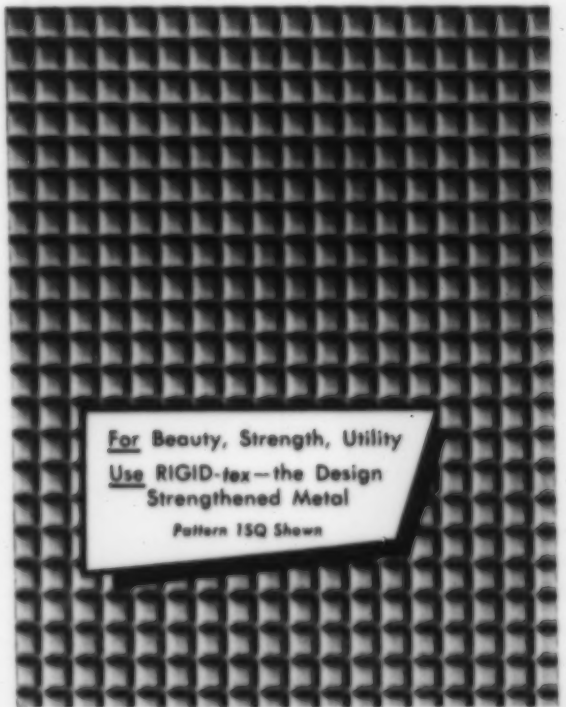
Control circuits are inductive, low power-factor loads. Any engineer knows transformers built for general use simply cannot serve such a circuit properly. That is why Cutler-Hammer Bulletin 10942 Control Transformers are a "must" with able control circuit designers. These transformers are designed specifically for control circuit applications. They assure correct regulation and faultless control performance. They are available in 60 to 5000 V.A. capacities, with two types of primary windings. Single winding primary for 220V, for 440V or for 550V. Dual winding primary, reconnectable for 220V and 440V. Wiring arrangements clearly shown on all nameplates. Be sure you have full information. Write today.



CUTLER-HAMMER TERMINAL BLOCKS FOR POWER AND CONTROL CIRCUITS

Correct design coupled with quality construction built the Cutler-Hammer worldwide reputation for dependable control performance. Cutler-Hammer Terminal Blocks are typical, built to only the highest standards. C-H Power Circuit Blocks are available in 70, 125, and 225 ampere ratings, with solderless pressure connectors. C-H Control Circuit Blocks are 25 ampere capacity in any multiple of 4 circuits up (4, 8, 12, etc.). They have washer-head screw type connectors. All blocks have correct electrical clearance to ground with large barriers against arc creepage. Write for samples and complete information. CUTLER-HAMMER, Inc., 1310 St. Paul Avenue, Milwaukee 1, Wisconsin.

CUTLER-HAMMER
MOTOR CONTROL
C-H



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. . . where you will find challenging opportunities, and receive professional recognition. Work and live in the beautiful Southern Tier of New York State. . . in an uncrowded rural atmosphere, with complete advantages of city life.

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Interviews in your area, or travel expenses paid if invited to Elmira for interview. Send resume.

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Electronic Tube Div. **Elmira, N. Y.**

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WANTED: Machine Design and Development Engineers. Graduate mechanical engineers with two to five years machine design and development experience are needed now for our rapidly expanding applied research program. Our informal operational and teamwork methods of accomplishment are especially attractive for those men who are looking for professional advancement and want to work on a variety of mechanical problems. All inquiries and letters of application handled promptly and confidentially. Please address replies to: The Personnel Manager, Battelle Memorial Institute, 505 King Avenue, Columbus 1, Ohio.

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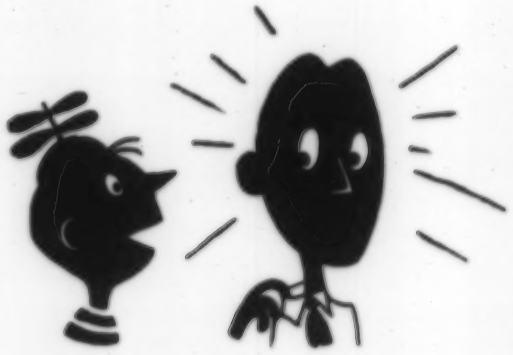
it pays to ask questions



Old, but true.

Many of us often miss out on a really good deal because we fail to get to the bottom of the matter. And so it might be with something you saw in an advertisement in this issue of MACHINE DESIGN. What you've been looking for might be right there in a package . . . except for one detail.

So, pop the question.

Fill out an advertising inquiry card and shoot it into us. We'll send your inquiry immediately to the advertiser and he will then reply directly to you.

USE THE YELLOW CARDS ON PAGE 33

Get yours while the supply lasts!

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18th Edition

the only one of its kind available anywhere

Order Form on Page 319

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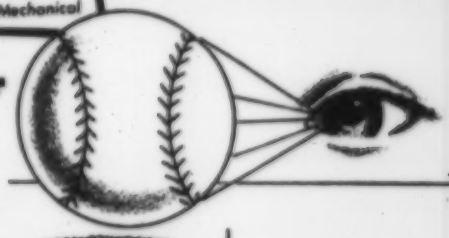
Electronic *Mechanical*



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In your career, as in successful baseball, golf or tennis, it pays to keep your eye on the ball. Keep your eye on the advantages only a young, yet securely established company can offer. Melpar is young enough to welcome new ideas, to recognize and award achievement, yet big enough to offer stability and growth to those who look to the future.

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Keep your eye on a career with Melpar, leader in electronic research and development.

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Revere insists on finest quality for every camera component . . . the best assurance there is of continued customer satisfaction!

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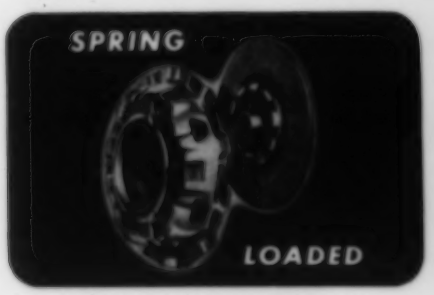

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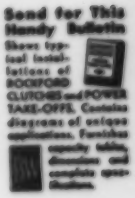

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CLUTCHES

Design for Low Control Cost...

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PUSH-PULL CONTROLS

Low in price, easy to install, there are seven standard Arens designs to meet light, medium and heavy load requirements. They are available with a variety of control heads, casings, and end fittings. Special controls can also be designed to meet specific requirements. Design with Arens Controls in mind . . . and save.

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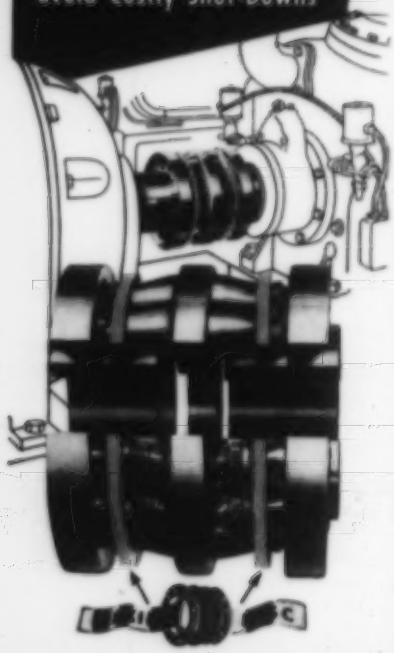
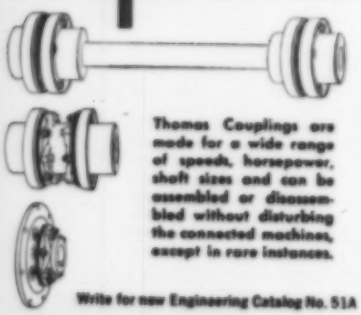
Specify THOMAS ALL METAL
FLEXIBLE COUPLINGS
for Power Transmission to avoid Costly Shut-Downs



Patented Flexible Disc Rings of special steel transmit the power and provide for parallel and angular misalignment as well as free end float.

DISTINCTIVE ADVANTAGES	FACT — EXPLANATION
NO MAINTENANCE	Requires No Attention. Visual Inspection While Operating.
NO LUBRICATION	No Wearing Parts. Freedom from Shut-downs.
NO BACKLASH	No Loose Parts. All Parts Solidly Bolted.
CAN NOT "CREATE" THRUST	Free End Float under Load and Misalignment. No Rubbing Action to cause Axial Movement.
PERMANENT TORSIONAL CHARACTERISTICS	Drives Like a Solid Coupling. Elastic Constant Does Not Change. Original Balance is Maintained.



Thomas Couplings are made for a wide range of speeds, horsepower, shaft sizes and can be assembled or disassembled without disturbing the connected machines, except in rare instances.

Write for new Engineering Catalog No. 51A

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.

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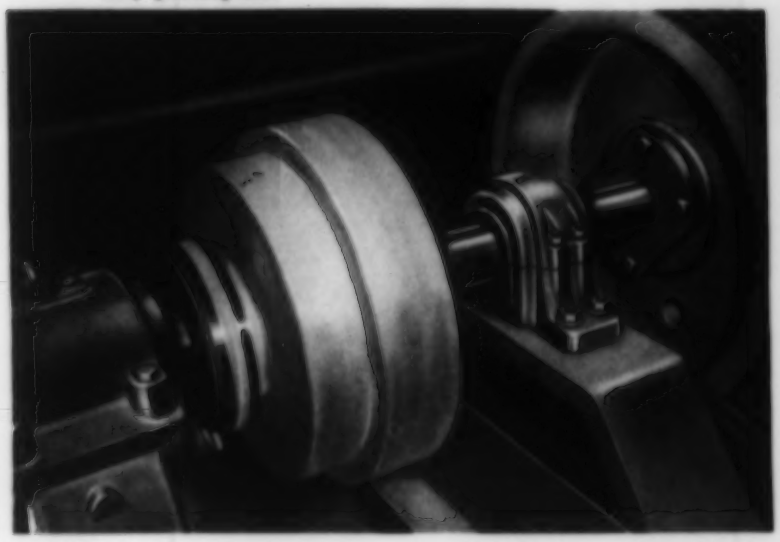
Here is one of the Stearns clutches installed at the Manitowoc Portland Cement Company. It transmits power from the motor to the preliminary grinding mill.



NO CLUTCH DOWN TIME

. . . even after 3 years of 24-hour-a-day service

Three years ago Manitowoc Portland Cement Company, Manitowoc, Wisconsin, installed Stearns magnetic clutches on two preliminary grinding mills used to crush stone to 20 mesh size. These clutches replaced heavy, outsized friction units which became misaligned and sometimes even twisted off and broke the drive shaft.

Not one cent of maintenance

The Stearns clutches are operating 24 hours a day and, according to James Dailey, superintendent and manager, they have not required a single adjustment or one cent of maintenance since installation. During this same period old clutches, still used on other grinding mills, broke down or required lining replacement . . . resulting in costly down time and loss of production.

Engage smoother, require less space

The Stearns clutches engage quickly, yet smoothly . . . require only ⅓ the space needed for the old clutches. They are controlled through convenient push buttons instead of hand levers.

Stearns magnetic clutches matched to your machine

Stearns offers clutches for equipment ranging from business machines to ball mills — and larger. Torque range from .1 lb ft to 30,000 lb ft. Available in a wide range of standard models or custom-built units to match your machine exactly. Get full details on the finest magnetic clutches available. Write today for bulletin 226-DJ.

1124

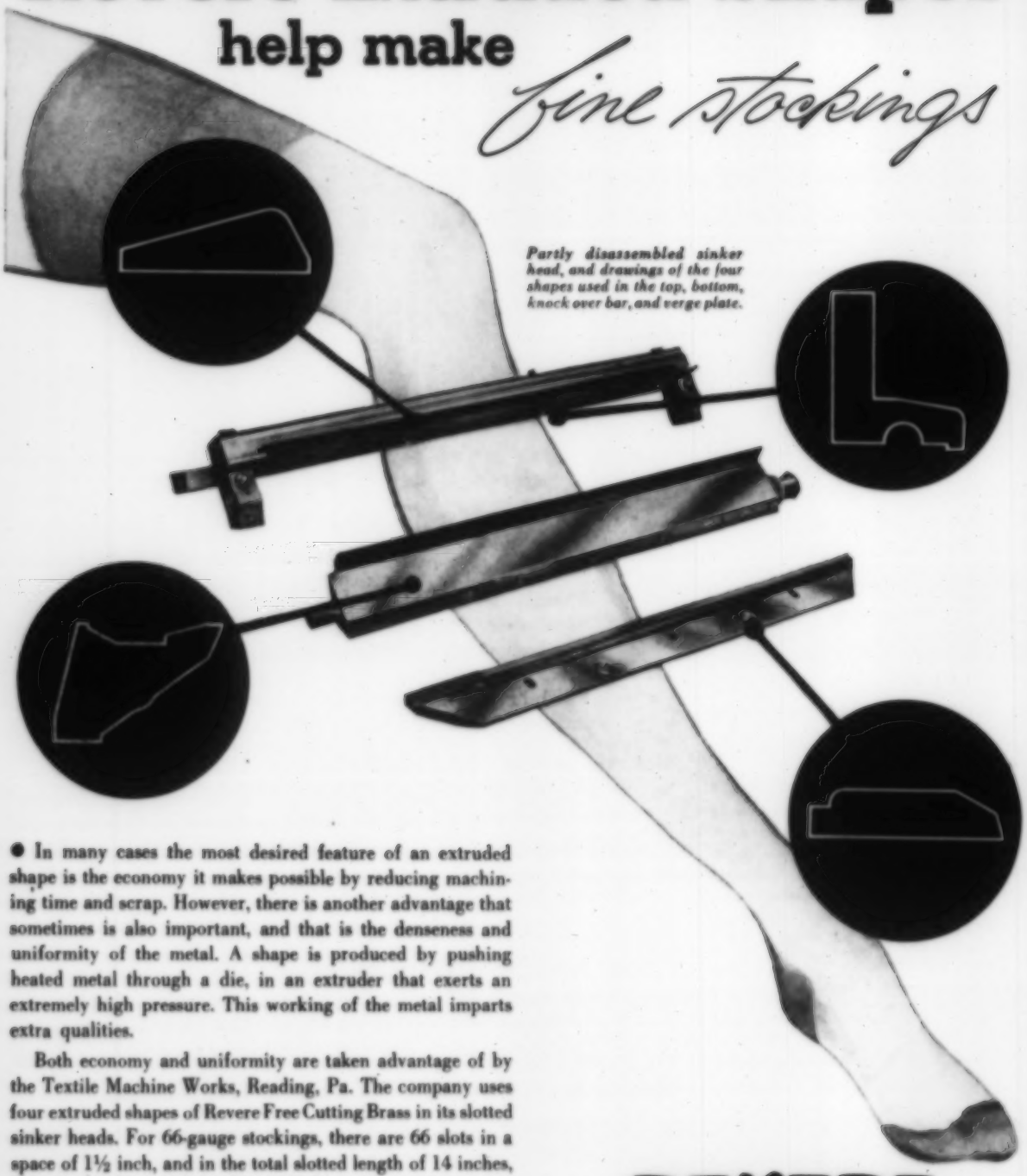
MAGNETIC EQUIPMENT FOR ALL INDUSTRY

STEARNS MAGNETS

STEARNS MAGNETIC, INC., 692 S. 28th St., Milwaukee 46, Wis.

Revere Extruded Shapes

help make *fine stockings*



Partly disassembled sinker head, and drawings of the four shapes used in the top, bottom, knock over bar, and verge plate.

● In many cases the most desired feature of an extruded shape is the economy it makes possible by reducing machining time and scrap. However, there is another advantage that sometimes is also important, and that is the denseness and uniformity of the metal. A shape is produced by pushing heated metal through a die, in an extruder that exerts an extremely high pressure. This working of the metal imparts extra qualities.

Both economy and uniformity are taken advantage of by the Textile Machine Works, Reading, Pa. The company uses four extruded shapes of Revere Free Cutting Brass in its slotted sinker heads. For 66-gauge stockings, there are 66 slots in a space of 1½ inch, and in the total slotted length of 14 inches, the tolerance is less than .001 inch. In order to achieve this accuracy, and be assured of straightness and flatness, Textile specifies shapes of extreme uniformity.

Perhaps your requirements are not quite so high as Textile's. Or perhaps they are higher. In either case, we shall be glad to explain how Revere Extruded Shapes can save you money, and at the same time help you maintain the highest quality standards. See the nearest Revere Sales Office.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

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Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.— Sales Offices in Principal Cities, Distributors Everywhere.

You can't beat the combination of the RIGHT horsepower, the RIGHT shaft speed, the RIGHT features all in one compact power unit that you can use RIGHT where you want it. It's the best way and the easiest way to select your power drives because you purchase one unit, handle one unit in your receiving, production, or maintenance departments . . . set one unit in place and you're ready to go.

Master Motors, available in thousands and thousands of ratings (⅛ to 400 HP) give you the widest selection of electric motor drives in the nation . . . permit you to use a power drive that will add greatly to the compactness, appearance, safety and economy of each of your applications.

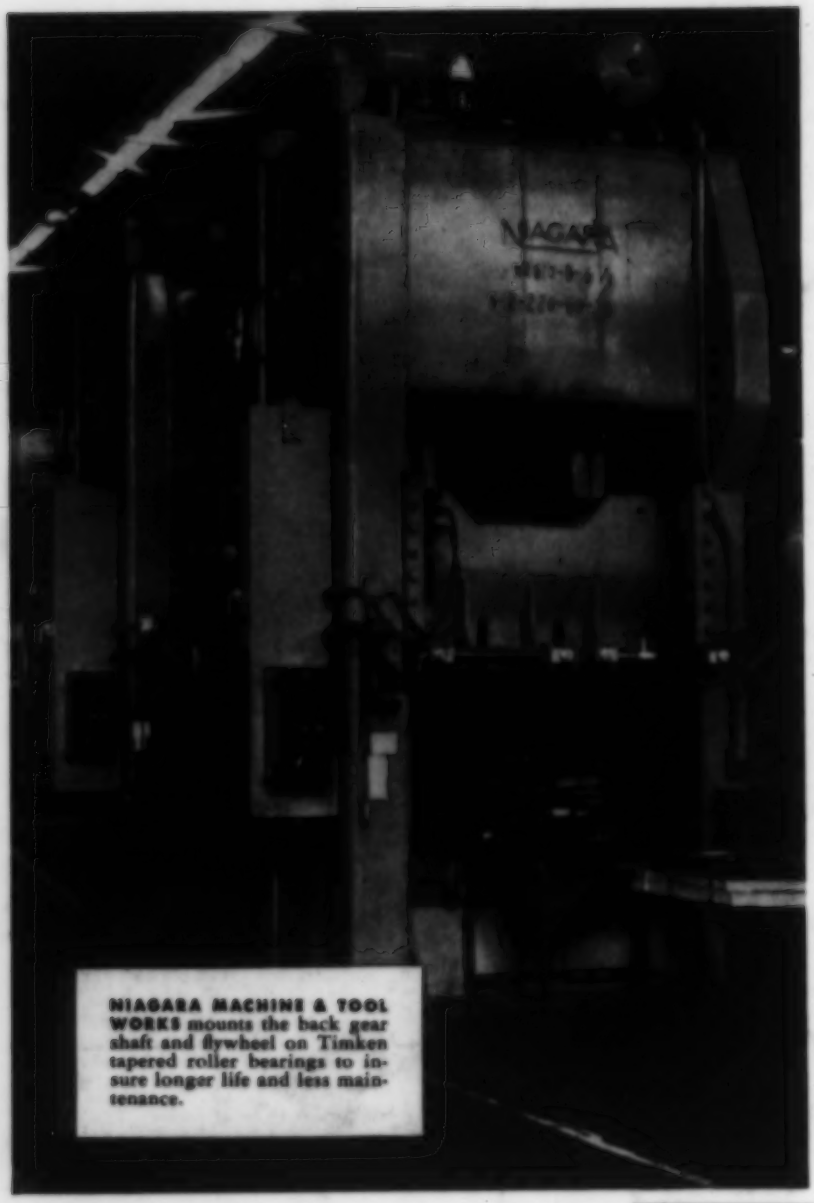
Use Master Motors to increase the salability of your motor-driven products . . . improve the economy and productivity of your plant equipment. They're the horsesense way to use horsepower.

THE MASTER ELECTRIC COMPANY • DAYTON 1, OHIO

easy solution

MASTER ELECTRIC MOTORS

How TIMKEN® bearings cut maintenance on auto body stamping presses



NIAGARA MACHINE & TOOL WORKS mounts the back gear shaft and flywheel on Timken tapered roller bearings to insure longer life and less maintenance.

MAINTENANCE and downtime are low in the stamping department of one large automotive manufacturer. One reason: 30 new-design Niagara double crank presses have the back gear shaft and flywheel on Timken® tapered roller bearings.

Every time the press stamps a part, the bearings on the back gear shaft take the heavy shock load. Timken bearings take these loads with ease because rollers and races are case-hardened. This gives them a hard, wear-resistant surface over a tough, shock-resistant core. Full line contact between rollers and races of Timken bearings gives them extra load carrying capacity to hold shafts in line. There's minimum maintenance, less downtime.

Timken bearings help gears last longer, too. They insure accurate gear mesh because Timken bearings' tapered construction lets them take both radial and thrust loads in any combination. The taper prevents lateral movement of the shaft. Flywheels do not become worn or loose, crankshaft wear is prevented.

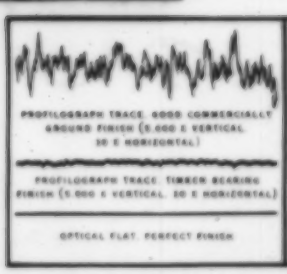
Be sure to specify Timken bearings for all the machinery you build or buy. They give longer life with less friction. Look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, O. Canadian plant: St. Thomas, Ont. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

TIMKEN

TRADE-MARK REG. U.S. PAT. OFF.

TAPERED ROLLER BEARINGS


PROFILOGRAPH TRACE, GOOD COMMERCIALLY GROUND FINISH (5,000 X VERTICAL, 50 X HORIZONTAL)
PROFILOGRAPH TRACE, TIMKEN BEARING FINISH (5,000 X VERTICAL, 50 X HORIZONTAL)
OPTICAL FLAT, PERFECT FINISH

SMOOTH TO MILLIONTHS OF AN INCH

Surface finish of high quality Timken bearing rollers and races is so smooth that it takes a profilograph to measure its smoothness. This instrument measures surface variations to a millionth of an inch, as shown at the left

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ▯ AND THRUST ⊣▯⊢ LOADS OR ANY COMBINATION